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AIRCRAFT

Space Is No Ivory Tower, R. C. TRUAX. Paper No. S112 (Detroit Sec) presented Oct. 1958, 7 p. Program of ARPA (Advanced Research Projects Agency, for military purposes), NASA (National Aeronautics and Space Agency, for peaceful purposes,) and NASC (National Aeronautics and Space Council, for determining overall space policy); problem of financing projects; danger of space control by USSR; creation of integrated organization answerable to both ARPA and NASA advocated; economics of big multipurpose rockets which should be promoted.

Aircraft Pneumatic Systems, W. C. GAGE. Paper No. S77 (Texas Sec) presented Sept. 1958, 10 p. New energy source available in jet engines, compressor bleed air, is used for driving accessory equipment, air conditioning, anti-icing, and cabin pressurization; necessity pointed out for stainless steel ducting and flexible assemblies; compression and tension duct systems described; types of flexible assemblies adaptable to tension system; pressure compensators; test facility and types of failures.

Tightrope to Tomorrow, J. F. HILL. Paper No. S78 (Texas Sec) presented Sept. 1958, 8 p. Basic equipment to provide atmosphere environment required for aircraft or missiles involves: altitude loop capable of over 100,000 ft simulated altitude with about 120 tons of refrigerating capacity available and air drying system for humidity control; h-p air storage system with large compressors supplying it; small cold, hot and humidity chambers for de-bugging uses and isolation of noises and temperature.

Status of SAE-12 Approach to Vibration Isolation of Aircraft Electronic Equipment, F. MINTZ. Paper No. 83A presented Sept.–Oct. 1958, 17 p. Progress made and approach taken to develop tentative design procedure, presented by case of simple center of gravity mounting system in which only vertical vibration is of interest; how problem is treated when finite mechanical impedance of source is significant factor, shown by two examples.

Development of Supressor and Thrust Brake for DC-8 Airplane, L. R. JORDAN, C. M. AUBLE. Paper No. 85A presented Sept.–Oct. 1958, 16 p. Development from initial test work to final design of jet noise suppressor and thrust brake, designed to give jet noise suppression of 9–12 db and 40% thrust in reverse; configuration selected for production consists of fixed, corrugated, suppressing nozzle with retractable ejector; target type thrust brake, mounted in ejector is air actuated; safety features.

DB's and Design-Engine Manufacturer's Point of View, H. J. NOZICK. Paper No. 85B presented Sept.–Oct. 1958, 9 p. Particular characteristics that contribute significantly to meet requirements of commercial turbojet engines; by satisfying requirements, problem of noise generation is alleviated; empirical method for obtaining sound pressure level data utilizing Lighthill's parameter.

Practical Experience on Thrust Re-

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versers, **K. I. C. VINCENT. Paper No. 85C** presented Sept.–Oct. 1958, 15 p. Test programs undertaken by Rolls-Royce Ltd., to obtain satisfactory solutions to problems involved; downstream and upstream reversers; upstream reverser with fixed outlets; tests undertaken on Derwent size unit and Avon size units; Avon thrust reverser for Comet III; Conway thrust reverser for Boeing 707–420.

Unleashing Air Freight's Potential, E. W. FULLER, R. F. STOESSEL. Paper No. 86C presented Sept.–Oct. 1958, 14 p. Factors affecting utilization of cargo aircraft, and effects of variations in elapsed time allowed for maintenance, loading and refueling; emphasis on principles of good design for maintenance; status report on research and development in process, goal of which is to increase aircraft utilization through decreasing ground time.

Air Conditioned Comfort on Douglas DC-8 Jet Transport, A. A. HERSHFIELD. Paper No. 87A presented Sept.–Oct. 1958, 13 p. Approach taken in design of components functioning as part of overall system, to maintain 70 F in passenger and crew areas at cruise altitude and ambient temperatures as low as – 100 F and max of 75 F on hot day ground condition of 95 F DB and 78 F WB ambient; temperature control system comprising 3-port mix valve; distribution system, controlled air movement and space temperature, etc.

Approach to Equipment Cooling Problems in Orbital Space Vehicle, J. S. TUPPER. Paper No. 87B presented Sept.–Oct. 1958, 18 p. It is shown that most promising systems are separate or integral storage type, utilizing water and ammonia as expendable coolants; operation of several control schemes presenting breadth of choice available between minimum refrigerant consumption and minimum of controls and complexity; methods of solving problems posed by weightlessness, high acceleration loading, installation and ground handling; recommendations.

Air Conditioning Propjet Transport —Lockheed Electra, J. G. KRISILAS, E. S. McCARTHY. Paper No. 87C presented Sept.–Oct. 1958, 27 p. Characteristics of Electra aircraft having bearing on basic design decisions; cabin air and flight station air distribution systems; fresh air required for pressurization and ventilation is obtained from engine inlet ducts of inboard nacelles; engine driven compressors; air cycle and vapor cycle refrigeration systems.

Low-Thrust Rocket Steering Program for Minimum Time Transfer Between Planetary Orbits, C. R. FAULDERS. Paper No. 88A presented Sept.–Oct. 1958, 20 p. Mathematical analysis of problem for rocket with constant thrust acceleration going from one planetary orbit to another, employing formal methods of calculus of variations; results of numerical integration for thrust-to-mass ratio of 10^{-4} "g"'s and final to initial radius of 1.5.

Automatic Flare Systems for Aircraft, Missiles, and Space Vehicles, E. R. BUXTON. Paper No. 88C presented Sept.–Oct. 1958, 18 p. Need for systems applied to commercial aircraft, drone and research vehicles, manned space craft, and recoverable missile boosters, is shown; automatic landing problems and limitations of exponential flare and path program systems; concept of 2-condition terminal flare controller, using altitude and altitude rate predictor; real time synthesis procedure provides direct design for servo problems of terminal control type.

DC-8 Fuel Systems Design Considerations, M. A. O'CONNOR, W. B. KING. Paper No. 89A presented Sept.–Oct. 1958, 19 p. Establishment of design requirements; 8-tank system consists of main and alternate tank for each engine; fuel feed by means of plug-in type tank mounted booster pumps, electrically driven; refueling system is capable of initial filling rate of 1400 gal per min; test program re-

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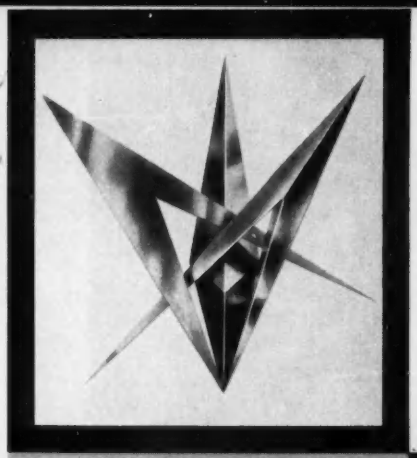

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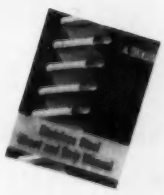

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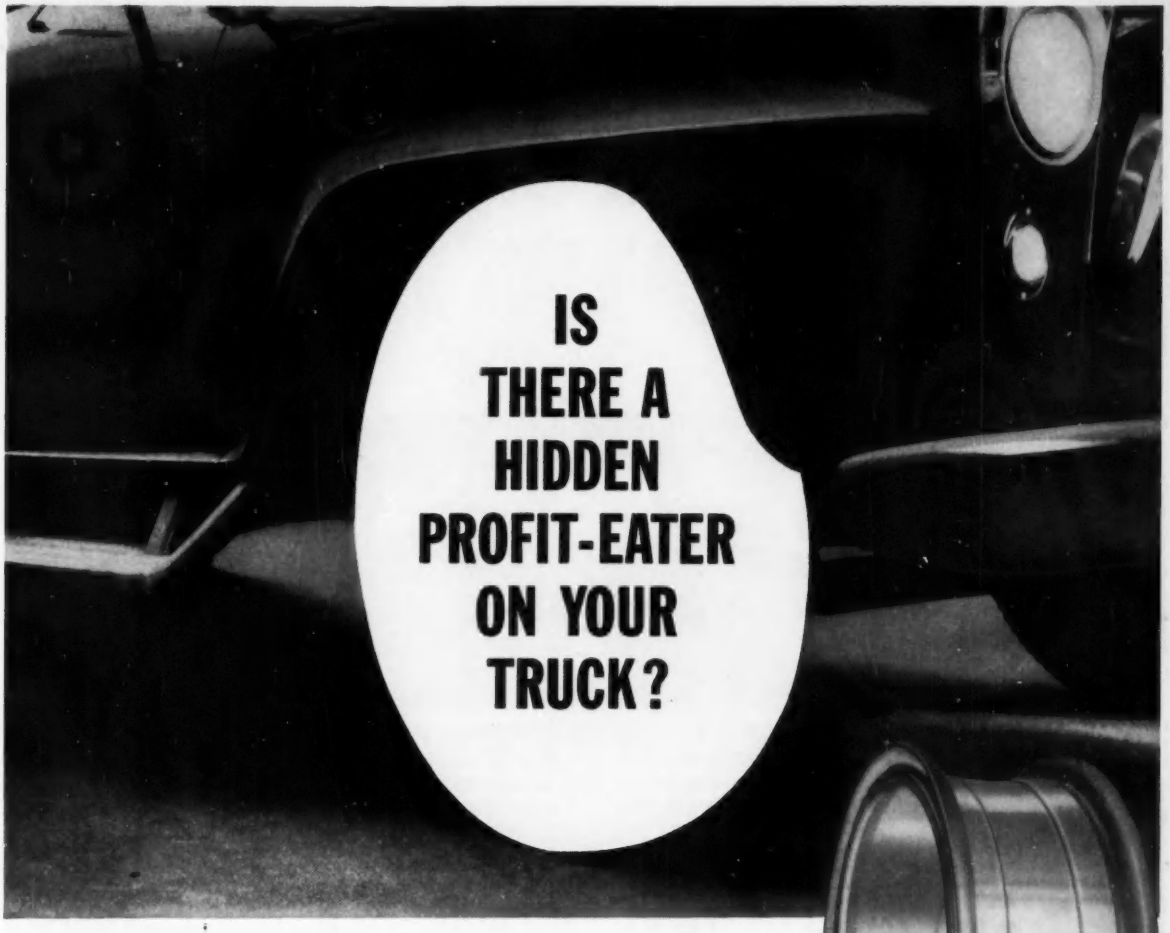
YOUR BEST BUY IS INDUSTRIAL BESTWALL® GYPSUM PRODUCTS

BESTWALL GYPSUM COMPANY • Ardmore • Pennsylvania • Plants and offices throughout the United States



IS THERE A HIDDEN PROFIT-EATER ON YOUR TRUCK?

Here's how Goodyear Rims can lick the problem!

Lowest-cost-per-pound item on your whole rig is the rim. Yet it can easily turn out to be one of the most expensive – *if improperly fitted.* Rims that are improperly fitted can cause as much as 30% loss in tire service.

To avoid costly early tire and rim failure, it's common sense to *specify the right size Goodyear Lightweight Rims* – job-fitted by Goodyear to insure longer tire life. They help reduce such common causes of tire failure as tread cracking, tread wear, sidewall failure, ply separation and bead failure.

Next time you think of rims, why not consider these savings you get with Goodyear Lightweight Rims. And you'll gain, too, from Goodyear's incomparable experience in building rims—the world's most complete line—for every type of vehicle. See your local distributor or write: Goodyear, Metal Products Division, Akron 16, Ohio.

Goodyear Lightweight Rim

First and only time-proved lightweight rim. Minimizes tread cracking, tread wear, sidewall failure, ply separation and bead failure.

Your tires go farther on RIMS by

GOODYEAR

MORE TONS ARE CARRIED ON GOODYEAR RIMS THAN ON ANY OTHER KIND

HARRISON AIR CONDITIONERS, HEATERS, RADIATORS, OIL COOLERS, THERMOSTATS ASSURE YEAR-AROUND PROTECTION AND PLEASURE!

Heat's no problem to Harrison. And leading manufacturers of cars and trucks will tell you why. Harrison supplies a complete line-up of temperature controls . . . providing all-weather comfort for passengers and dependable year-around protection for engines and transmissions. The result of Harrison's more than 48 years' experience in the heat-control field, these quality products are engineered to assure you of efficient, trouble-free operation. Backed by the most complete research facilities in the automotive heat-transfer field, Harrison's ready to give you a hand. There's no challenge too big, or no problem too small! If you have a heating or cooling problem, look to Harrison for the answer.

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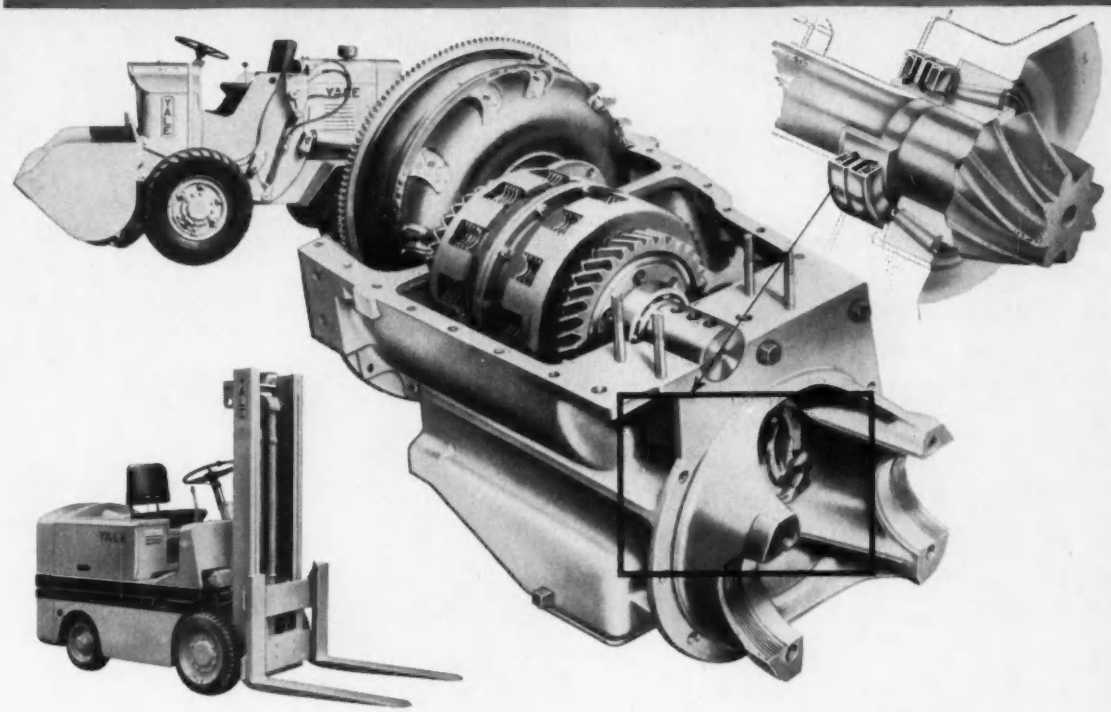
AUTOMOTIVE RADIATORS • OIL COOLERS • THERMOSTATS • AIR CONDITIONERS • HEATERS • DEFROSTERS

GM GENERAL MOTORS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK

NATIONAL OIL SEAL LOGBOOK



Oil seals "back-to-back" in torque transmission of Yale industrial tractor shovels

In both their new industrial tractor shovels and the famous KGA51 series lift trucks, Yale and Towne employ National Seals to separate transmission oil from differential lubricant. The seals are used at the pinion position of the unique, fully automatic Yale Torque Transmission. This assembly is basically a combination of a torque converter and a constant mesh transmission eliminating gear shifting.

Pinion sealing almost always presents unique demands on oil seals; performance must be of the highest order since most pinion seals are difficult to reach for replacement after assembly, and repairs to adjoining assemblies are costly.

To assure long-term, trouble-free performance for their customers, Yale and Towne install two 50,000 series National Seals at the pinion position. The seals are mounted back to back, one with its lip facing and retaining transmission oil; the other with its lip facing and retaining differential lubricant. Both seals used are standard-design National Micro-Torc leather seals with precision-made tension springs insuring optimum seating of lip on shaft.

National offers over 2,500 different standard-design oil seals — leather, synthetic rubber or felt. National Seal engineers are at your service—they're listed under Oil Seals in the Yellow Pages.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

Micro-Torc*— National's "break-through" in leather seals

Micro-Torc Oil Seals, developed by and made only by National, have established new performance standards for leather seals. They absorb less power, run cooler and last longer than any leather seal made. Properly employed, they have *no measurable leakage* throughout service life.

Micro-Torc Oil Seals are produced by *coating*—not impregnating—chrome retanned leather with a dry lubricant in an elastomer binder. The result is a mechanically stable sealing member which does not leak oil *through* the leather, but does permit the unimpregnated central part of the leather to absorb oil for periods of momentary lubricant starvation.

See, feel the difference!

Micro-Torc sealing lips actually *look* and *feel* slicker, smoother — their cool-running, high-lubricity coating is plainly apparent to the touch. Ask your National Seal engineer to let you *feel the difference!*

the Pioneer in space

To send the U.S. Pioneer more than 60,000 miles into interplanetary space, Space Technology Laboratories in seven months designed, developed, assembled, and tested an 88-foot combination of three integrated stages with a payload incorporating 36 separate ignition systems. STL's Astrovehicles Laboratory focused on the payload itself and the sensitively related problems of propulsion, weight, and stability. These are in addition to the overall complexities of the structural configuration.

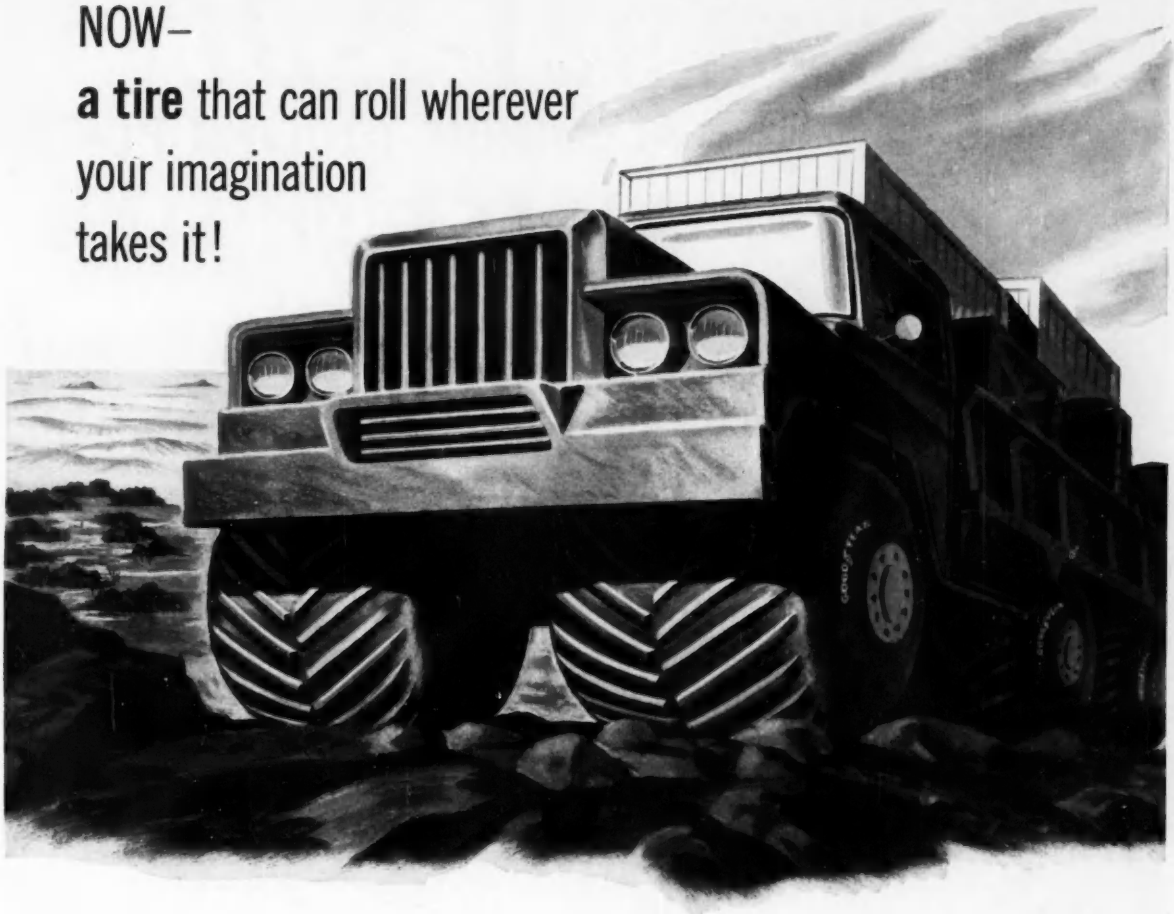
Pioneer, setting new apogees in science and missilery, typifies the achievements STL is making in the advancement of space technology. Those who are able to contribute to and benefit from these developments are invited to consider joining our staff.

Space Technology Laboratories

Members of STL's
senior technical staff
will be available for personal interviews
at the
Institute's 27th Annual Meeting,
Hotel Astor, New York City,
January 26-29, 1959.

Space Technology Laboratories, Inc.
5730 Arbor Vitae Street, Los Angeles 45, California

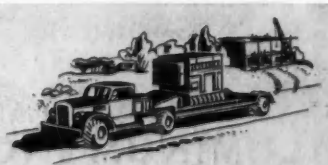
NOW–
a tire that can roll wherever your imagination takes it!



This is the Terra-Tire—developed by Goodyear to give military vehicles unprecedented mobility. It is now ready for commercial applications wherever a tire is needed to traverse *any* terrain without miring down or digging in. Axle-driven and axle-loaded, these air-filled "pillows" *conform* to the ground contour—give with sharp objects rather than resisting them, are virtually immune to punctures and blowouts. And since Terra-Tires carry only 3 to 10 pounds' pressure — the ride is so cushion-soft springs aren't needed!

Want to roll over sand without slipping? Terra-Tires are now being used for beach cleaning.

Need a tire with an "invisible" footprint? Terra-Tires won't even harm a golf green.

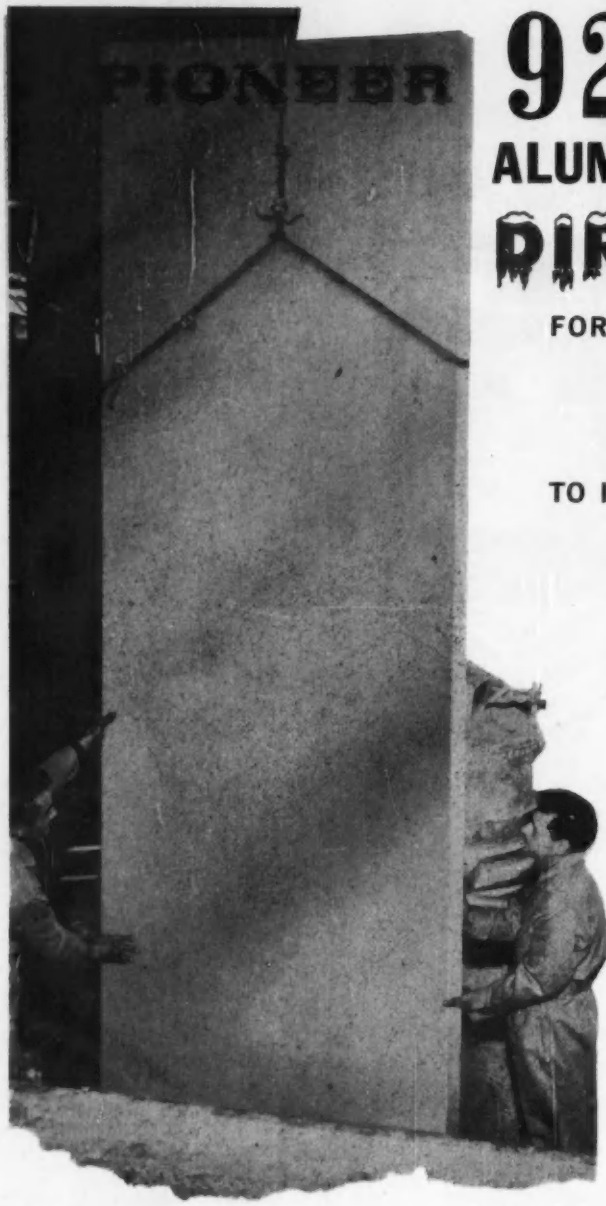


Looking for a tire that will carry a heavy load over improved surfaces —without danger of damage to the load or the road?

WHERE CAN **TERRA-TIRES** SAVE FOR YOU? DESIGNERS: by designing vehicles **from the start** to utilize the unique engineering advantages of Terra-Tire transportation, substantial savings in space and weight can be realized. For more information, contact Goodyear, Aviation Products Division, Akron 16, Ohio.

GOODYEAR

Terra-Tire—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio



921-T-*DC*

ALUMINUM TOOLING PLATE

DIRECT CHILLED

FOR *Greater Density, Less Porosity and Improved Stability*

TO INSURE:

1. EASIER MACHINABILITY
2. PRECISE DIMENSIONS
3. SUPERIOR FLATNESS
4. BETTER SURFACE FINISH
5. LOWER COST TOOLING

These five outstanding advantages are possible because, starting with a finer grain structure and an inherent stability not approached in any other lightweight tooling material, each 921-T-*DC* tooling plate is machine finished to exact dimensions before shipment.

Not only is 921-T-*DC* being used by leading airframe, automobile, appliance and other metal working industries for jigs, fixtures and production tools, but is finding acceptance for use in the manufacture of precision equipment and components where close tolerances, uniformity and stability are prime requirements.

GET THE FULL STORY

• • • A complete description of Pioneer 921-T-DC; its versatility and adaptability; illustrations of applications, are contained in a new brochure available without cost or obligation through any of the Pioneer distributors listed below.

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AiResearch centralized air data computing system...

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The AiResearch centralized air data computing system integrates pneumatic, electronic, electrical and mechanical components on one of the Navy's fastest jets. It senses, measures, and automatically corrects all air parameters affecting flight. It supplies air data information to the pilot and all major airplane subsystems.

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Eliminating duplication of components, the AiResearch centralized air data computing system cuts down space and weight requirements over decentralized systems by many times. Its principal functions: angle of attack, true static pressure (electrical and pneumatic), true air speed, true Mach, altitude, rate of climb, total temperature, dynamic pressure and altitude and Mach error.

AiResearch has been the leader in the development of centralized computing systems. The F4H-1 installation is the first, single package air data computer possessing completely interchangeable, modular construction.

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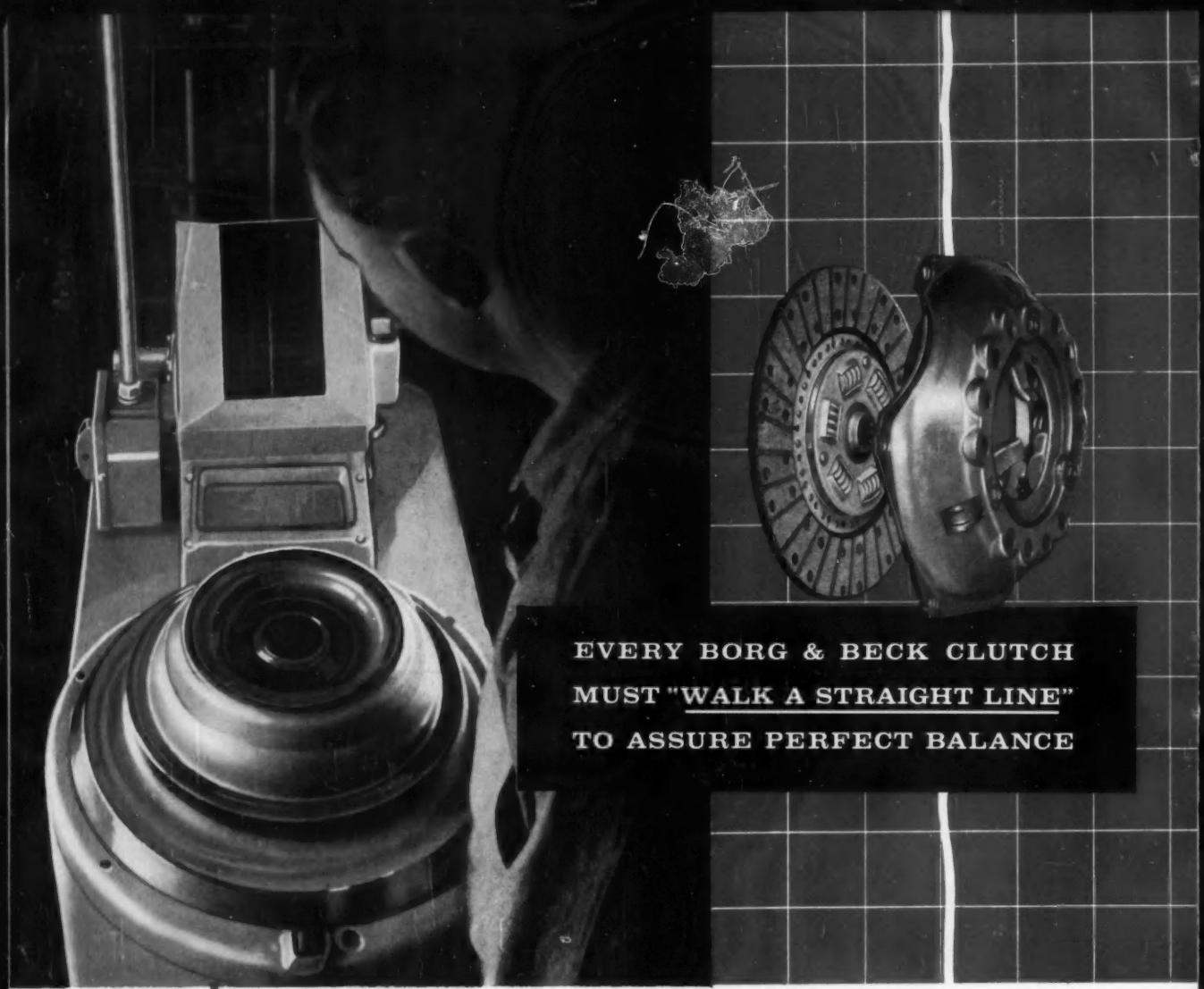
Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS



EVERY BORG & BECK CLUTCH
MUST "WALK A STRAIGHT LINE"
TO ASSURE PERFECT BALANCE

Probably the most important single quality in a clutch is *balance*—because balance means smoothness of operation, not only of the clutch but of the engine as well.

That's why Borg & Beck clutches are checked for balance, at operational speeds, on specially designed test machines. Even the slightest unbalance is instantly detected and carefully corrected. Perfect balance is assured, as shown above, when the electric beam of the oscillograph is vertically straight on the calibrated screen. And every Borg & Beck clutch must "walk this straight line" before it passes inspection.

This is typical of the extra care that goes into every step in the making of Borg & Beck clutches. It is your assurance of top quality, top performance, top value.

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THE AUTOMOTIVE STANDARD FOR MORE THAN 40 YEARS

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The Standard of Quality and Performance Since 1813 Has Proven Its Place in the Automotive Industries in 1959

Few American companies—and no other in the automotive field except Saco-Lowell—can point to 145 years' experience in precision metal manufacturing. But Saco-Lowell, founded in 1813 by Francis Cabot Lowell, and with a solid foundation of craftsmanship, *pioneered* in precision manufacture as applied to textile machinery and laid the humble beginnings of what is now the hallmark of the automotive industry—*mass production*.

TODAY this heritage is extended to automotive parts and ordnance materiel and parts.

Saco-Lowell has for several years proven itself as a producer of universal joints, differential gear case assemblies, exhaust control valves, pinion and side gears and rear axle shaft assemblies. It previously has proven itself in the manufacture and assembly of machine guns.

What Saco-Lowell has done for others it can do for you.

To intensify our service for you, the automotive buyer, Saco-Lowell has established an Automotive Division, with general sales offices in Detroit. Buyers of automotive parts with an immediate quality problem and not unduly allergic to savings resulting from our Yankee frugality are asked to call or write for our new Automotive Division brochure.

SACO-LOWELL AUTOMOTIVE DIVISION

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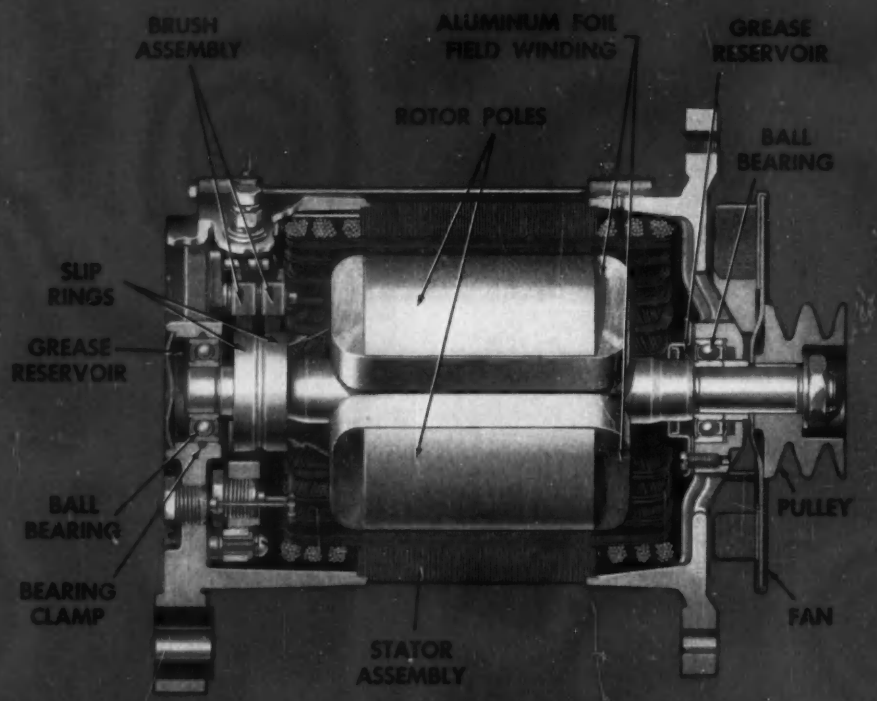
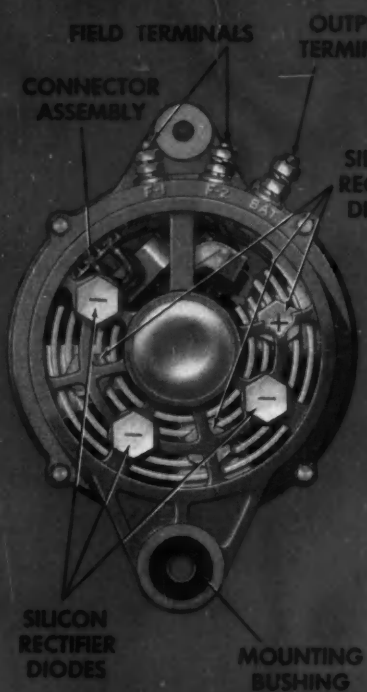
NOW! REAL CHARGE-AT-IDLE,

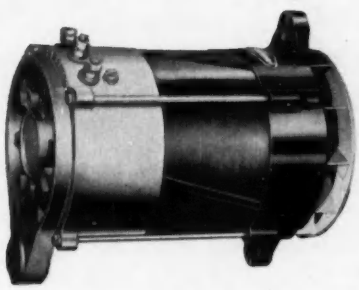


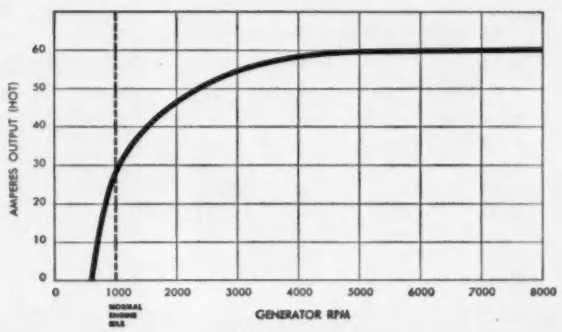


PROGRESSIVE ENGINEERING MAKES THE DIFFERENCE

UP TO TWICE THE TOTAL OUTPUT

WHEN YOU REPLACE STANDARD D.C. EQUIPMENT WITH DELCO-REMY'S NEW SELF-RECTIFYING A.C. GENERATOR





Here's a completely new generator from Delco-Remy *specifically designed* to take care of cars and trucks with extra-heavy electrical loads under all traffic conditions . . . to increase battery life by eliminating deep cycling.

Designed to mount interchangeably with most standard d.c. generators, this compact new unit is only 5¾″ in diameter and weighs just 31 pounds. The a.c. design eliminates commutation problems, providing extra-long brush life . . . and the ball bearings are "lifetime" lubricated so that no attention is required between engine overhaul periods. Six specially developed silicon rectifiers built into the end frame eliminate the need for space-consuming external rectifier units, reducing installation time and cost to a minimum.

Be sure to specify this new self-rectifying a.c. generator along with its companion transistor regulator (either full or transistorized model) on your new special-duty equipment for 1959. This all-new power team is still another example of Delco-Remy progressive engineering at work for you.

GM GENERAL MOTORS

GENERAL MOTORS LEADS THE WAY—STARTING WITH **Delco-Remy** ELECTRICAL SYSTEMS

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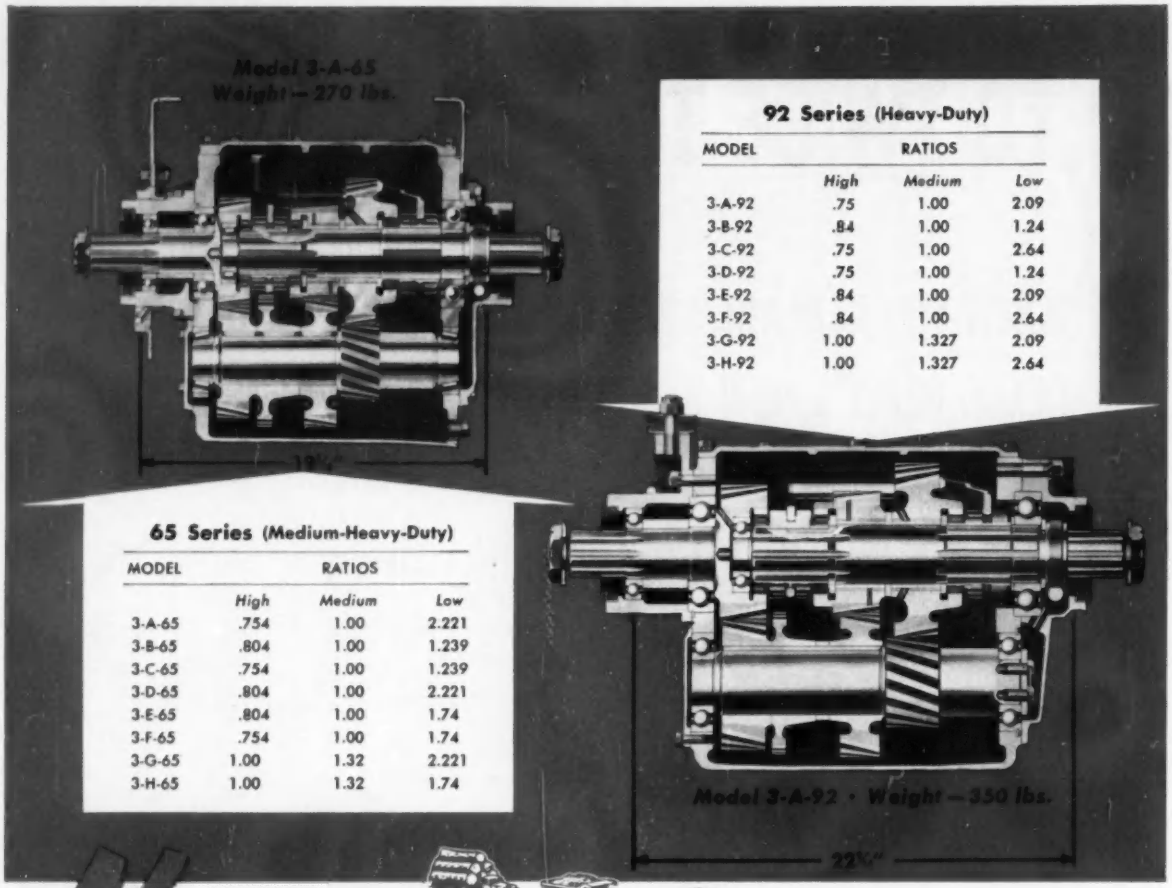

92 Series (Heavy-Duty)

MODEL	RATIOS		
	High	*Medium*	*Low*
3-A-92	.75	1.00	2.09
3-B-92	.84	1.00	1.24
3-C-92	.75	1.00	2.64
3-D-92	.75	1.00	1.24
3-E-92	.84	1.00	2.09
3-F-92	.84	1.00	2.64
3-G-92	1.00	1.327	2.09
3-H-92	1.00	1.327	2.64

65 Series (Medium-Heavy-Duty)

MODEL	RATIOS		
	High	*Medium*	*Low*
3-A-65	.754	1.00	2.221
3-B-65	.804	1.00	1.239
3-C-65	.754	1.00	1.239
3-D-65	.804	1.00	2.221
3-E-65	.804	1.00	1.74
3-F-65	.754	1.00	1.74
3-G-65	1.00	1.32	2.221
3-H-65	1.00	1.32	1.74

Now ...the most complete line of 3-speed AUXILIARY Transmissions

The Fuller Manufacturing Company now offers the most complete line of three-speed auxiliary transmissions . . . for transport, logging, construction, mining and crane carrier services . . . at lower prices than competitive units in a comparative capacity range.

The extremely rugged heavy-duty 92 Series has been completed by the addition of 5 new sets of gear ratios, Models 3-D-92 through 3-H-92. Four new sets of gear ratios, Models 3-E-65 through 3-H-65 have been added to the medium heavy-duty 65 Series.

Split Gears and GO

The expanded line of three-speed auxiliary units includes splitting ratios, both underdrive and overdrive. With these splitting ratios, the engine can operate at maximum horsepower through a full range of vehicle speeds. Ideal for over-highway operation, the extra gears allow faster schedules, greater profits.

Deep Reductions

Deep reductions, in combination with splitting ratios, offer maximum flexibility both on and off-highway where the deep reduction is required for extreme grades and soft footing, and where splitting efficiency is required for traffic conditions.

Longer Equipment Life

With engines working in the most efficient torque and horse-power range, there is less lugging . . . less wear . . . and greater fuel economy. Result: lower maintenance costs, less downtime, longer engine and transmission life.

FULLER

Fuller

TRANSMISSIONS

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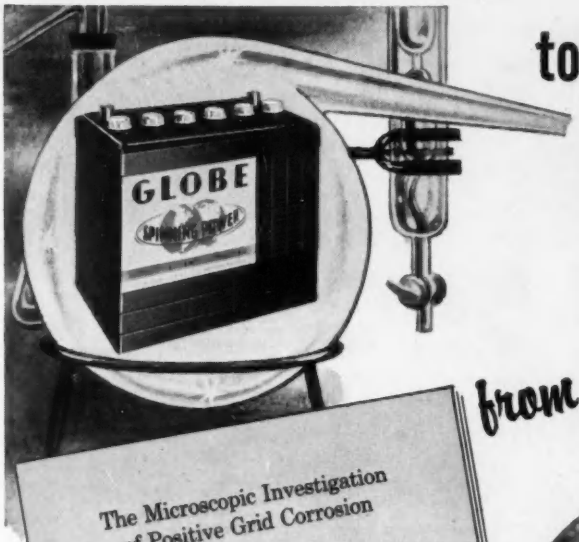
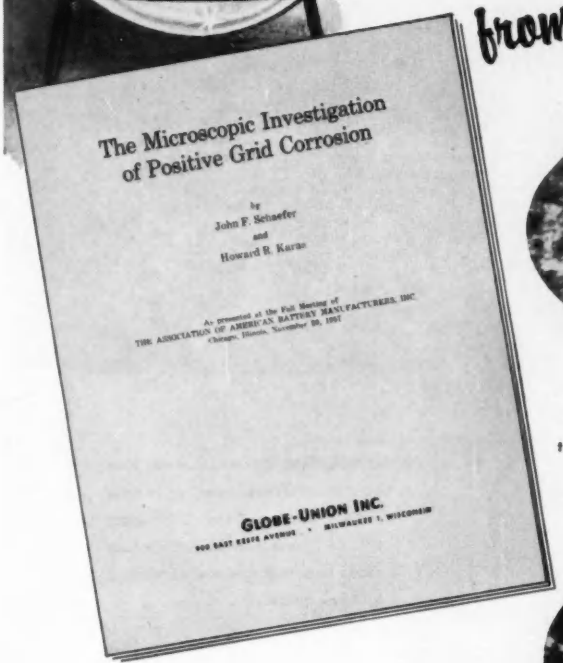


to Globe-Research no battery is ever perfect...

from GLOBE RESEARCH THIS SIGNIFICANT GRID CORROSION STUDY



Corrosion standing* . . . cross-section of a grid bar from a battery which stood two years without attention in an unheated garage shows typical corrosion pattern.

Corrosion in service* . . . grid section from a battery after two years of actual service. 21,000 miles of driving shows 20% corroded.

Corrosion—standard cell* . . . grid section from standard cell of battery in 1000-mile-per-day Test Fleet service, shows 28% grid metal loss after 191,500 miles service.

**Microscopic pictures of grid sections 100-magnification.*

Globe-Union Research engineers and chemists regard every new battery as a challenge — are determined to find flaws even in their own Globe products. For from such impartial and exhaustive analyses have come the continuous improvements in Globe batteries for over 25 years . . . spurring battery developments throughout the entire field.

One example of important Globe research is the study offered here: a very thorough 20-year examination of the corrosion of positive grids — a major cause of service failure of lead-acid storage batteries. The sampling of subjects shown suggests the range of this study. And because we believe the material, approaches and conclusions will be of special interest to you, a copy is available at no cost if you will simply fill out and mail the coupon.

For original equipment or replacement, Globe Spinning Power Batteries are readily available from 16 strategically located plants.

SPINNING POWER
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SPLIT-SECOND STARTING

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GLOBE-UNION INC.
Research Dept., Milwaukee 1, Wisconsin

Please send me, without cost or obligation, a copy of your Research study, *The Microscopic Investigation of Positive Grid Corrosion.*

Name.....

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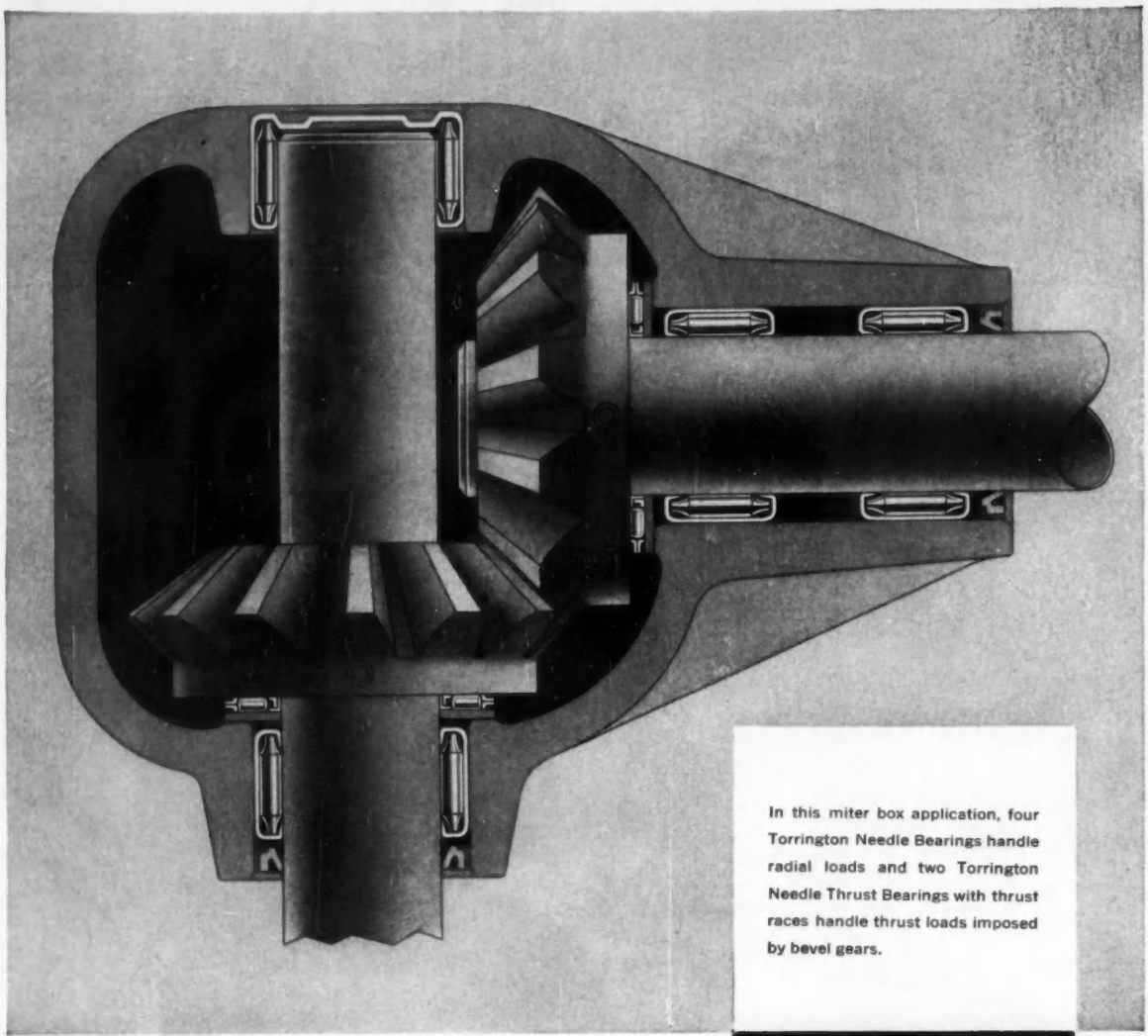
Firm.....

Address.....

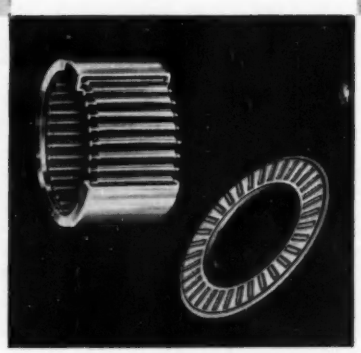
City.....Zone.....State.....

If it's Petroleum-powered there's a GLOBE-BUILT BATTERY right from the start!



In this miter box application, four Torrington Needle Bearings handle radial loads and two Torrington Needle Thrust Bearings with thrust races handle thrust loads imposed by bevel gears.

Perfect Combination for Thrust and Radial Loads



Here's a space-saving, cost-saving way to handle high thrust and radial loads. Just team up Torrington Needle Bearings with Torrington Needle Thrust Bearings!

With their full complement of small diameter rollers, Needle Bearings handle higher radial loads than any other anti-friction bearing of comparable cross section. And Needle Thrust Bearings are only .0781" thick — as thin as an ordinary thrust washer. Together they make a perfect combination of compact, light, rugged anti-friction bearings.

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For the Sake of Argument

How, How Much, and To What . . .

LIFE depends greatly on how, how much, and to what we respond in our everyday rounds. The man who responds constructively to great crises is not unusual; it's the one who can react "I'll-bet-we-can" a hundred times a day. When pricked by a problem, he doesn't attack the person who brought it. He goes right at the problem itself.

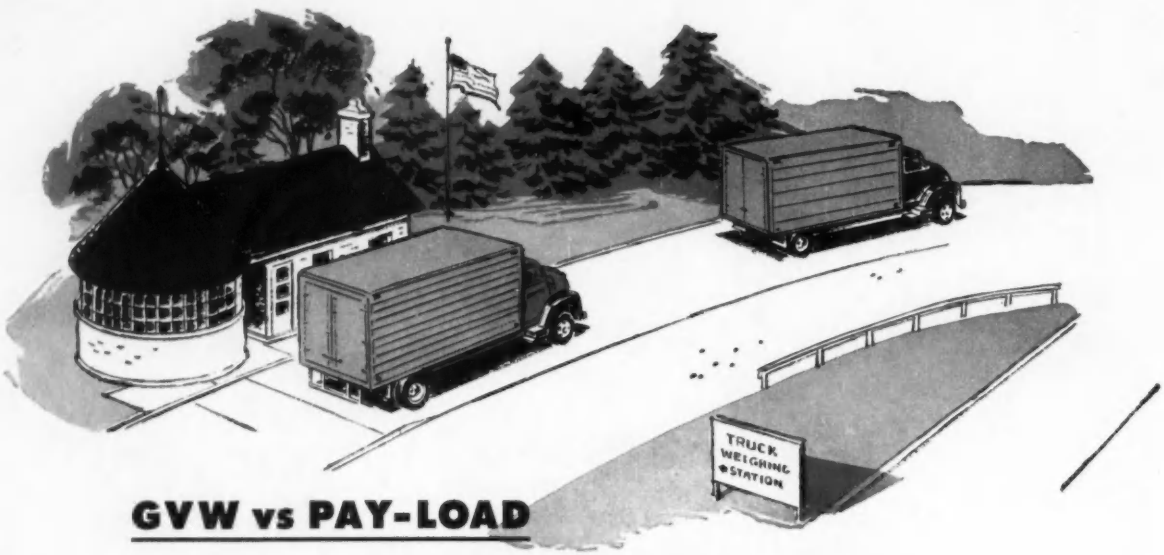
Faced with fateful decisions, most of us manage somehow to reach beyond ourselves and draw into focus sources of help hitherto unknown. History abounds with men who have done just that. But fewer are those who regularly take a positive course when forced to choose between petty uncertainties.

"The man who tells you that people are basically greedy and ambitious — ignoring the plain fact that they are also kind and self-sacrificing — is saying more about himself than about the world," says columnist Sidney Harris. And each tells his own story by words and actions in the minutiae of daily exchanges with his associates.

"Big" responses to small problems form habits which give a life story a happy ending. The man who saves his "big" responses for big problems can finish life without a single chance to be "big." The right combination of humility and wisdom will bring right response to every problem every day; not only on the once-in-a-lifetime problem.

We tend to judge ourselves by our motives; others by their actions, Dwight Morrow once reminded. So, others can be expected to judge us by our responses to people, events, and problems. These responses, these actions reflect the thoughts which *are* our life.

Norman G. Shidle



GVW vs PAY-LOAD

WHERE A POUND SAVED IS A DOLLAR EARNED!

By saving dead weight, vacuum power can add several hundred pounds to pay-load, and earn extra dollars, as ton-miles build up.

In addition there is vital safety in having physical braking instantly available should power fail for any reason.

For these and other important reasons, vacuum power is the overwhelming choice on trucks, and HYDROVAC* leads all other makes combined.

...It will pay you to look into

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chips

from SAE meetings, members, and committees

INCREASING ANTIKNOCK REQUIREMENTS has been drastically reducing the range of useable gasoline hydrocarbons for many years. At the turn of the century several hundred were acceptable. Today a major share has been eliminated — and the number may be reduced to 50 or less in the next several years — because of the struggle against the increasing knocking tendencies of modern engines, according to Shell's L. E. Hebl.

ADOPTION OF FLUID-TYPE AUTOMATIC TRANSMISSIONS is also indirectly reducing the number of hydrocarbons available for modern cars, according to Hebl. Reason: The higher speed Motor method gives more significant results than the Research method for these cars, with their high engine speed loading . . . and only a few fuels rate 100 octane or more by the more severe Motor method. In all, about a hundred olefins are being made undesirable for gasoline by this trend — with leaded isoparaffinic alkylates, a few leaded aromatics, and such volatile fuels as leaded butane and isopentane being about all that are left.

A PROMISING BIT OF RESEARCH is going on in reducing three dimensional clay model surface information to two dimensional line drawings on sheets of paper or aluminum. Machines which can make precise drawings from complex surfaces are already in use in the aircraft industry. It is only a matter of time when the automotive stylist and body engineer, too, will enjoy such aids to speed and accuracy, saving considerable labor in transposing such surfaces.

But let's go a step further — let's have our "surface reader" control wood and metal cutting tools directly from the model . . . taking signals from drawings or the model surface to generate die models or perhaps even metal dies.

The uncanny Keller contour milling machine is already familiar in the field of wooden die model-to-metal die reproduction. The next step — to link the styling model to the die shop — is obvious. Assurance of accuracy, and the resultant savings in time and cost, will make not only automobiles but all sheet metal products cheaper and better for everyone.

FLYWHEEL-DRIVEN BUSES in Switzerland are said to travel up to 3 miles before they have to stop to get a new charge for their inertia powerplant. While far from an ideal powerplant for American vehicles, this Swiss unit does incorporate a way of retaining the energy of the power unit during braking rather than throwing it away each time.

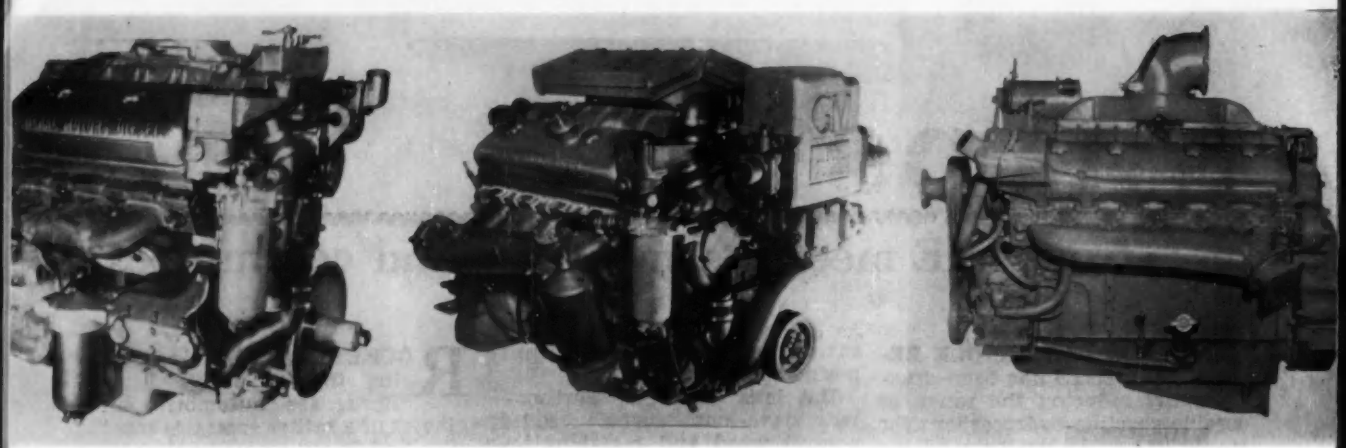
DESPITE a rapid increase in government appropriations for guided missiles, electronic devices used in conventional aircraft continue to dominate the electronic industry's total output, with factory sales estimated at $2.03 billion for 1958.

Products used in missile guidance constitute the next largest category at $1.13 billion, a substantial increase over the $700 million in 1957. The Pentagon tentatively pegs 1959 cash outlays for missiles and related equipment 15% higher than 1958.

ROCKET ENGINEERS, according to Cal Tech's J. D. Burke, are "automotive engineers of a rather eccentric sort." . . . And Burke reacts to the possibility of transatlantic television's being the first commercial application to result from satellites in permanent orbit by saying: "I am personally horrified at the thought!"

LIQUID-COOLED BRAKES and liquid-cooled driveline retarders are in an advanced state of development for truck use. Indications are that a requirement of approximately 150 hp will handle gross loads of 50,000 lb with sufficient absorption ability to run out normal 5 to 6% grades at 35 to 40 mph, without excessive coolant temperature buildup. The units will not actually be an *added* heat load for the cooling system, since the engine will be developing little or no power while the brake-cooling takes place.

MOST MEDIUM SIZED SHOPS, says Sun Electric's A. T. Cashel, allow approximately 5 cents per preventive maintenance hour for test equipment. To determine the amount you can economically spend, take the total number of vehicles and multiply by the total number of miles driven per year by the average vehicle. Then survey your preventive maintenance program to determine how many preventive maintenance hours will be expended for the total miles traveled. Multiplying the total maintenance hours by 5 cents will tell you how much you can afford for test equipment.



Detroit Diesel's New V Diesels Feature:

•Maximum Economy

•Parts Standardization

•Minimum Weight

Based on paper by

K. L. Hulsing and C. E. Ervin

Detroit Diesel Engine Division, GMC

THREE principal ground rules were laid down for design of the new Detroit Diesel V-71 Series (and also the 53 Series) engines. These are:

- Maximum fuel economy at conservative ratings.
- Maximum use of standard parts, particularly those of higher service usage.
- Minimum weight and space per horsepower.

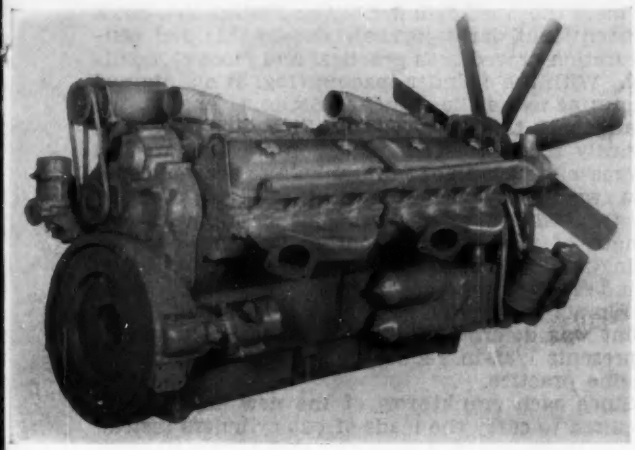
The first requirement was met by incorporating the design and performance characteristics of the existing 71E (economy) engines into the new series.

To attain maximum use of parts already in production and widely distributed in the field, standardization on present 71E engine pistons, rings, wristpins, and cylinder liners was carried even further in the V-71's. Interchangeability was extended to cylinder heads, rocker covers, exhaust manifolds, timing gears, injectors, valves, injector and valve operating mechanisms, flywheels, and many other high-volume items.

Much existing equipment and tooling were utilized for similar new engine parts, including flywheel housings, Roots blowers, connecting rods, and camshafts. This high degree of design standardization has permitted and justified extensive new multistation tooling, particularly in the case of the cylinder block and head lines.

Minimum weight was achieved in the new line by a general reduction of casting walls to 3/16 in., wherever consistent with good structure and foundry requirements.

With these ground rules, the V-71's actually began to design themselves. The transverse cross-section



In addition to the V diesels shown here, Detroit Diesel's new V-71 series includes a 24-cyl unit (twin 12V) and a 32-cyl unit (twin 16V). The smaller 53 Series also contains one "V" — a 6-cyl diesel.

(Fig. 1) shows, for example, how the Roots blower was placed on top of the block in the middle of the V. Use of existing 71 cylinder heads then placed the exhaust manifolds on the outboard sides and the push-rods and camshafts on the inboard sides of the banks. The two contrarotating camshafts, permitting complete balance of primary rocking couples, dictated the 63½-deg V angle by virtue of their established timing gear size and fixed location relative to the crank center. By use of this slightly unconventional V angle, the goals of parts standardization and minimum engine width were achieved with no loss in operating smoothness.

The three basic box sections of the block consist of the crankcase, airbox, and water jackets, with internal tension members tying through from the head bolt bosses to the main bearing bulkheads. For added longitudinal and transverse rigidity and bore alignment, the tension members are tied in by a "shelf" at the tops of the lower cylinder liner bore stock.

Cylinder Liners

The dry cylinder liner used in the in-line Series 71 was selected for the V-71 because of paramount considerations of production and service standardization. It should be noted that water cooling is required only above the cylinder air inlet ports. Adequate cooling of the lower cylinder section is provided by scavenging airflow, and is aided by oil jet cooling of the piston crown by means of a drilled connecting rod and spray orifice.

The length of the V engines (Fig. 2) was set up by the established 3, 4, and 6-71 cylinder heads with their 5¾-in. cylinder center distance. Even with the left bank staggered 1.2 in. ahead of the right bank and some additional length due to necessary water passage coring at the front, the V-71 blocks are less than 2 in. longer than their in-line counterpart with half the number of cylinders. The V-71 blocks are made in three sizes, 6V, 8V, and 12V; the 16V consists of two 8-cyl blocks attached together "front to front."

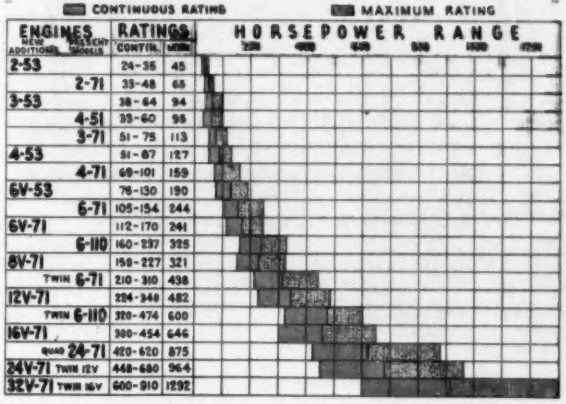
Initially a barrel-type crankshaft was considered

TWO new series of diesels have been added to the Detroit Diesel line: the smaller 53 Series (which contains one V engine) and the V-71 Series (which, as its name implies, is all V engines).

How the new diesels fit into the existing line of production engines (the in-line Series 71 and 6-110 engines) in terms of power rating is shown on the chart below.

The V configuration was chosen for all the new engines (except the very small 2-, 3-, and 4-cyl 53 Series) because of its inherent size and weight saving characteristics. For example, the new 6V-71 engine is 40% shorter and 15% lighter than the in-line 6-71 engine.

The accompanying story shows how the V-71 Series was designed to attain maximum economy, parts standardization, and minimum weight. The complete paper also gives similar data for the 53 Series diesels.



Horsepower comparison for complete line of Detroit Diesel engines.

Detroit Diesel's New V Diesels

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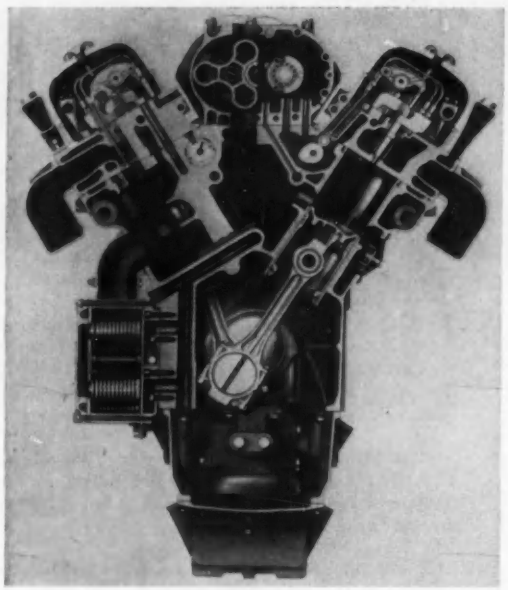

Fig. 1 — Transverse cross-section of 12V-71 engine.

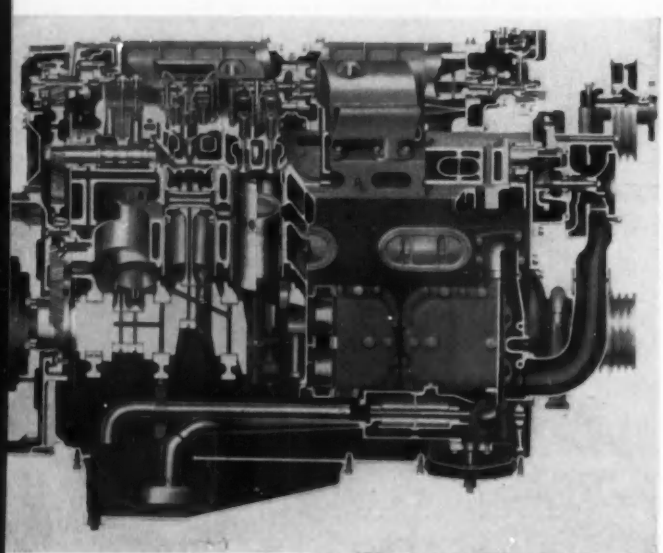

Fig. 2 — Longitudinal cross-section of 12V-71 engine.

to meet the fixed cylinder center limitations, but a conventional, large-journal, side-by-side rod configuration proved both practical and more economical. With the cylinder spacing (Fig. 3) maintained the same as on the standard Series 71 engine, the crankcheek thickness of the V-71 engines was necessarily reduced. This reduction was required to increase the length of the crankpin to accommodate the two side-by-side connecting rods. In addition to the reduced crankcheek thickness, the useful length of the crankpin journal was increased by using minimum fillet radii and allowing a minimum grinding wheel-to-crankcheek clearance. The minimum fillet radius from a manufacturing standpoint was determined to be 0.100–0.130 in., which represents 1/32-in. reduction from standard in-line engine practice.

Since each crankthrow of the new engines was required to carry the loads of two cylinders instead of one, both the crankpin and main journals were increased in size. This increase in diameters was from 3.5 in. to 4.5 in. on the main journals and from 2.75 in. to 3.0 in. on the crankpins. The diameter of the crankpin had a definite limitation (Fig. 4): the big end of the connecting rod had to be able to pass through the 4¼-in. cylinder bore. By decreasing the bearing shell thickness 1/32 in. and notching the bearings at the split line for clearance with the cap bolt, the ¼-in. increase in rod bearing diameter was achieved. It was necessary, however, to equalize areas on the joint face of the cap to eliminate bearing distortion that resulted from unbalanced unit loading by the cap bolt.

Stress analyses were made to determine if the strength of the new crankshaft with its reduced crankcheeks would be satisfactory. The resistance of the crankshaft to bending fatigue (Table 1) was evaluated for the critical section, from the crankpin fillet through the crankcheek to the main journal fillet. This showed that a section modulus could be obtained to reduce bending stress 10% below that of the proved in-line 6-71 crankshaft. The ability of the crankshaft to transmit torque was evaluated by comparing the shear stresses in the crankcheeks nearest the flywheel end, when the maximum instantaneous torque was being transmitted. The increased shear also shown in Table 1 was secondary, since the shear stresses were of much lower magnitude than the bending stresses.

The large overlap obtained with the increased journal diameters, and the increased width of the elliptical crankcheek are shown in Fig. 5. Following current practice, the resistance to bending fatigue was increased by rolling the fillet areas of the journals to create a residual compressive stress in the crankshaft where the maximum bending stress occurs. It is of interest to note here that the standard method used to evaluate the quality of fillet rolling on sample 6-71 engine crankshafts is to operate the engine at full load with the No. 2 main bearing removed. This imposes a stress almost three times the normal, and 100 hr operation without fracture constitutes proof that the crankshaft is satisfactory for normal engine operation.

Main and Connecting-Rod Bearings

After the crankshaft was judged to be sufficiently strong to carry the loads to be imposed upon it,

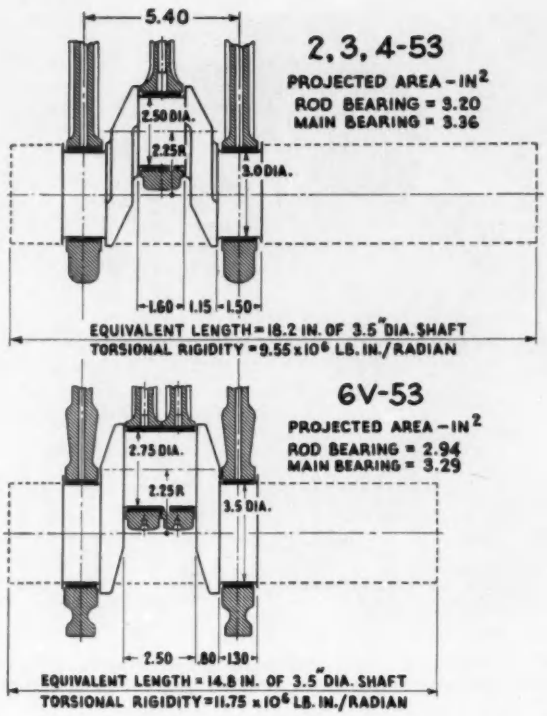

Fig. 3 — Comparison of crankthrows for in-line 71 Series and V-71 Series.

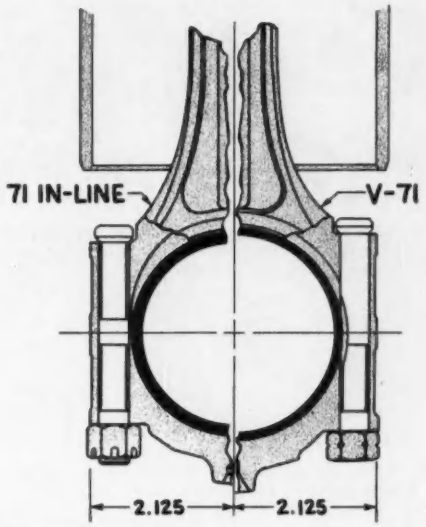

Fig. 4 — Comparison of connecting rod for in-line 71 and V-71.

bearing loads were calculated to insure that the unit bearing pressures agreed with accepted practice on our standard engine. Many calculations were made to determine the highest loaded bearings, and to determine if it would be desirable to decrease the loads by placing counterweights on the crankshaft adjacent to the heaviest loaded bearings. These tedious and time consuming calculations were only practical because the actual calculations were carried out by an IBM 704 electronic computer. By taking advantage of the increased journal diameters and by the strategic placement of counterweights, conservative peak unit bearing pressures were obtained, and mean pressures were achieved that were within the 1000–1400-psi limits of good practice, even for engine loads 15% above normal intermittent ratings.

Another consideration of prime importance in the design of a crankshaft is the torsional vibration characteristic. Usually, it can be said that a crankshaft that is torsionally correct will not lack in strength in either bending or torsion. The torsional vibration characteristics of the models 6-71 and 12V-71 crankshafts compared favorably. Use of a single, viscous damper, of the large size now in production, cut the 12V-71 torsional amplitude in half, bringing it to a satisfactory 0.42-deg double amplitude.

Engine Balance

In the balance of 2-stroke engines, it is important to consider disturbances due to the reciprocating action of the piston masses. These disturbances are of two kinds: unbalanced forces and unbalanced

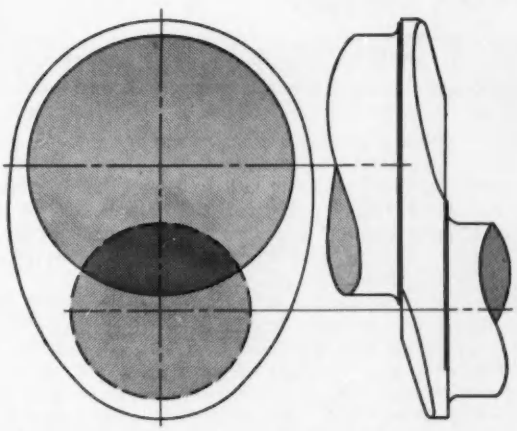

Fig. 5 — Crankshaft web construction showing large overlap obtained with increased journal diameters, and increased width of elliptical crankcheek.

Table 1 — Crankshaft Strength Comparison

	6-71 Engine	12V-7 Engine
Crankcheek Section Modulus, in.³	0.93	1.18
Relative Bending Stress, %	100	90
Polar Section Modulus, in.³	1.57	2.00
Relative Max Shear Stress, %	100	122

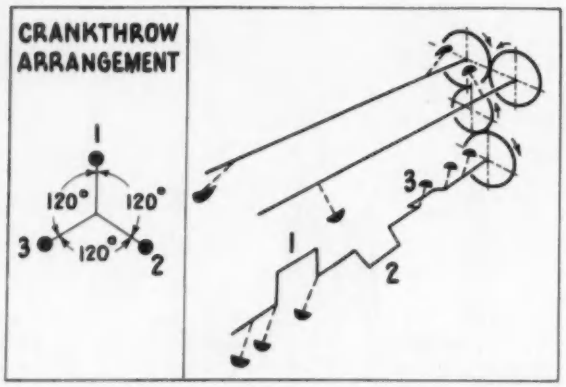

Fig. 6 — 6V-71 balancing system. Primary couples are balanced with counterweights on camshafts and crankshaft. Counterweights on crankshaft are for rotating and reciprocating balance.

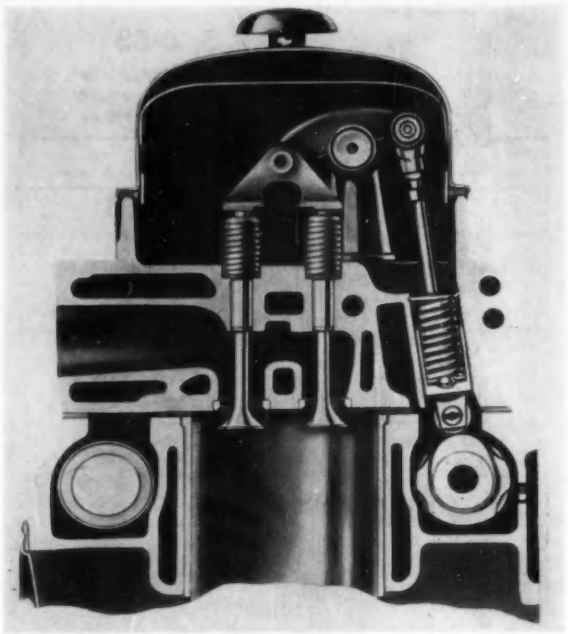

Fig. 7 — Four-valve operating mechanism of cylinder head incorporates new, stamped clevis-type bridge, actuating transverse pairs of valves.

Detroit Diesel's New V Diesels

. . . continued

couples. These forces and couples are considered as primary or secondary according to whether they occur at engine speed or twice engine speed. Although it is possible to have unbalanced forces or couples at frequencies higher than the second order, they are of small consequence in comparison to the primary and secondary forces and couples.

Since it was desirable to maintain the same V angle in all the engines in the new series, an extensive investigation was made of balance requirements of 63½-deg V-angle engines having 6, 8, 12, and 16 cylinders. Many crankthrow arrangements were considered and the resulting effects upon crankshaft balance, firing interval, and engine balance were evaluated. The final selection for each engine was that which gave the best balance among all the considered factors.

The 6V-71 engine crankshaft throw arrangement (shown in Fig. 6), for example, results in an engine which has inherently balanced primary and secondary forces and has a firing interval which deviates by only 3.5 deg from an even 60 deg. Balance of the primary rocking couples is accomplished by balance weights placed on the crankshaft and on the two camshafts, where they are conveniently made integral with the camshaft drive gears in the rear, and the accessory drive gear and pulley on the front of the engine. Rotating balance of the crankshaft is accomplished by the placement of counterweights as shown.

Cylinder Heads

Of particular interest is the 4-valve operating mechanism of the cylinder head (Fig. 7), which features the short push-rod design and the standard roller cam followers of the in-line Series 71, but incorporates a new, stamped clevis-type bridge, actuating transverse pairs of valves. This simplified bridge automatically balances valve lash, and reduces spring and high-speed follow problems by virtue of its light weight. It eliminates difficult service adjustment procedures, and in addition, survives under conditions where some more complicated, guided devices fail.

Only three different cylinder heads serve seven basic engines. A 3-cyl head is used on the 6V-71; 4-cyl heads are used on the 4-71E, 8V-71, and 16V-71; and 6-cyl heads are used on the 6-71E and 12V-71. In all designs, fuel supply and fuel spill passages (Fig. 8) are drilled in the head, supplanting previous external, fabricated fuel manifolds. Greater flexibility of connection is achieved, and vulnerable parts are eliminated. Fig. 9 illustrates how the shorter 3- and 4-cyl heads accommodate either the separate, side-outlet water manifolding of the present in-line 71's, or a front end outlet for the 6V and 8V-71's. The separate, side outlet manifold and cross-flow through the cylinder head is employed on the 12V-71, as well as the in-line 6-71.

Fig. 8 — In-line 71 and V-71 fuel manifolding. Fuel supply and fuel spill passages are now drilled in head, supplanting previous external, fabricated fuel manifolds.

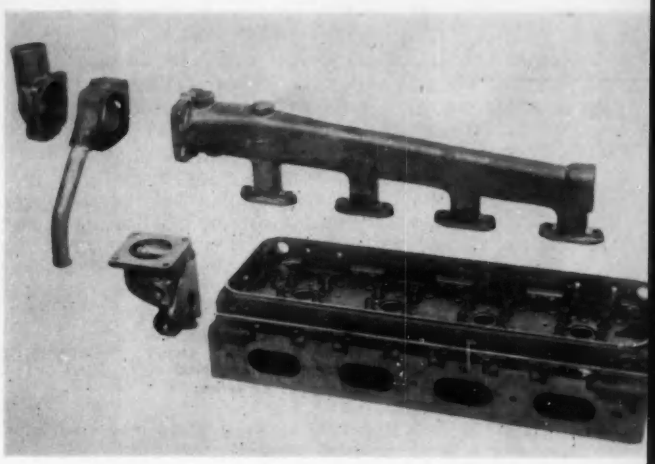

Fig. 9 — In-line 71 and V-71 water manifolding. Note how shorter 3- and 4-cyl heads accommodate either separate, side-outlet water manifolding of present in-line 71 engines, or front end outlet for 6V and 8V-71 engines.

This is done to obtain better coolant distribution in the relatively longer 6-cyl head, where transverse water jacket area and increased coolant flow become limiting factors.

Lubrication System

The V-71 engine lubrication system shown in Fig. 10 has been designed to accommodate the same tooling for the 6-, 8-, 12-, and 16-cyl engines. Except for the oil pump, the 12V-71 system illustrated is typical of all the engines. The 12V and 16V oil pumps are located in the oil pan and mounted on the main bearing caps optionally at the front or the rear of the engine. Pump design is such that it will accommodate either left- or right-hand rotation merely by switching the positions of the drive and driven shafts, while internal body passages accommodate connection to the oil coolers and filters mounted on either the right or the left front corner of the block. The design also permits tandem installation of a scavenging pump section when required for such applications as earthmoving vehicles.

Full-flow filters are placed in the system ahead of the plate-type oil coolers to protect them along with the rest of the engine. External oil coolers, common to all present in-line engines, have been retained on the new engines, due to their versatility of configuration and capacity as required for high-output engines and oil-cooled application components.

All cylinder block oil passages are drilled and are necessarily large since the 16V's oil flow rates exceed 50 gpm. There are no external oil lines subject to breakage, which can so easily occur in the heavy-duty operation for which these engines are designed.

Oil flows from the coolers to the main, longitudinal gallery in the middle of the block. Thence, each main bearing is individually pressure fed, passing oil to an adjacent pair of connecting rods by way of grooves in the unloaded halves of the main and rod bearings and appropriate crankshaft drilling. The rifle-drilled connecting rods carry oil to the piston-pin bushings and provide the oil jet cooling spray for the piston crown.

Additional vertical passages off the main gallery carry oil to the camshaft end bearings in each bank and out the top of the block to the cylinder heads. Longitudinal galleries paralleling the camshaft connect with leads to the blower for drive gear and bearing lubrication.

Oil entering the rifle-drilled camshafts through the end bearing journals passes to the intermediate bearings, where it is jetted against the camshaft lobes and cam rollers running in an oil bath. This jet lubrication of lobes and rollers is very important immediately after starting with cold oil, before camshaft bearing oil flow, and oil drainage from the head, have had time to build up.

Cylinder head and cylinder block oil drainage provisions were designed for adequate drainback under extreme operating angles and have proved satisfactory for inclinations over 45 deg in any direction. Consequently, the V-71 engines are capable

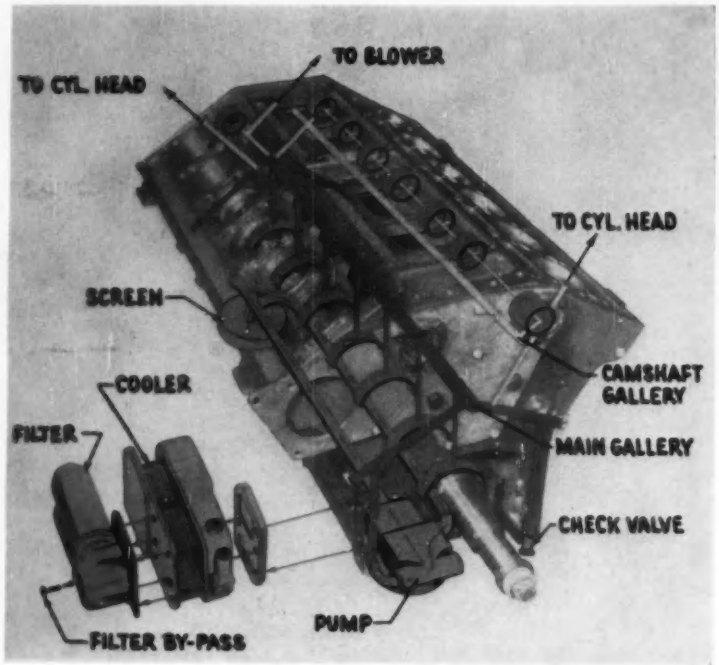

Fig. 10 — 12V-71 lubrication system, which except for oil pump, is typical of all engines of series.

Detroit Diesel's New V Diesels

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of being permanently mounted with either bank laid over as far as horizontal, by modifying only the oil pan and oil pump inlet.

Since the 6V and 8V-71 engines are intended for highway vehicles as well as earthmoving and stationary applications, oil pan clearance with front axles was a major consideration. To permit greater design freedom, the 6 and 8V oil pump was taken out of the sump and placed in the crankshaft front cover in a somewhat unique arrangement employing easily manufactured spur gears. The main pumping gear is concentric with, and spline driven on, the front end of the crankshaft. The pump idler gear is much smaller than the main gear, and it runs on a well-lubricated copper-lead bushing and hardened steel shaft. With careful attention to inlet porting, the pump has been developed to give over 90% volumetric efficiency, a characteristic, no doubt, of better tooth filling with a large-diameter, narrow-width gear running no faster than engine speed.

Cooling System

The gear-driven, curved-vane water pumps are designed to deliver a maximum of 20 gpm per cylinder. It was felt that this high capacity should be

Fig. 11 — 12V-71 tandem blower configuration and governor.

available to minimize costly radiator size and meet the ever greater cooling requirements of special application components such as torque converters, marine gears, and torquematic brakes. Simple substitution of lower output impellers permits tailoring of water flows for specific applications where flow requirements are lower and an economy of pump horsepower is desirable.

A full-flow, blocking-type bypass system protects the engine from excessively choked-down coolant flow during high load operation under cold-weather conditions. About 80% of maximum pump delivery goes through the bypass with the themostats closed, and modulation of water temperatures into the block is provided by the large bypass capacity. An added dividend of the system is equalization of coolant flows and temperatures through the two V-cylinder banks. Since each bank has its own thermostat and housing tied into the common bypass, complete closure of one thermostat, with the other open, only results in a 56% versus 44% divison of pump delivery between the banks, with practically no difference between the two "water out" temperatures.

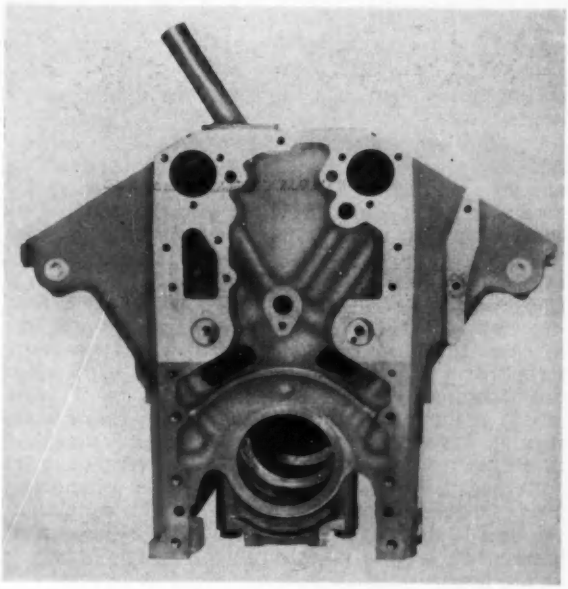


Fig. 12 — Internal crankcase breather for V-71 Series.

Gear Train and Accessory Drives

The V-71 timing gears are standardized with the in-line 71. Separate balance weights are bolted to the two camshaft gears suitable for the engine involved. The idler gear runs on a preloaded roller bearing; bearing and hub are both standard in-line engine parts.

The combination gear train cover and flywheel housing is not only machined on present in-line 71 tooling, but is even cast with the same pattern equipment using various optional loose pieces. For this reason, a large number of existing production accessories and drives are directly applicable to the new V-71 line. Engine speed drives are available on both camshaft gears, while the blower and one optional gear offer two, twice-engine-speed drives. In addition, three multisheave pulley drives are available on the front ends of the camshafts and crankshaft.

Scavenging Blower

Location of the Roots blower on top of the block assures equal distribution of scavenging air to both banks, and has obvious advantages for air cleaner piping and service accessibility. Furthermore, by nesting the blower between the two cylinder heads, a minimum silhouette is attained, while the sides of the block are left clear for optional accessory location and maximum frame clearance. Relatively shorter blowers for given capacities were possible because the blower to block joint face location and resulting drive-gear centers permitted designing for a 2.05/1 drive ratio, compared to the standard 71E 1.69/1 ratio. Using the blower rotor contour and housing bores established by existing volume tooling, it was practical to design a tandem blower configuration (Fig. 11) for the 12V-71 and 16V-71, so that only two basic blowers serve all four V-71 engines. Further, on the same gear centers, it is possible to provide a blower drive gear to give a 1.95/1 ratio more closely tailored to the requirements of a turbocharged version of the engine.

The top-of-block location of the blower also offers a convenient mounting and 2/1 drive for the fuel pump and governor. The governor housing is integral with the blower front cover, and is so located that simple linkages can connect directly through the sides of the cylinder heads to the standard Series 71 bellcrank and injector rack control mechanisms.

Crankcase Breathing

Crankcase breathers always present a problem. Regardless of where they are installed on an engine, they always interfere with some accessory, frame member, engine mount, or other special condition in the multitude of varied applications encountered. Fig. 12 shows how, in an effort to get away from this once and for all and to approach a design insensitive to installation and operating angles, an internal crankcase breather has been incorporated in the rear end of the cylinder block. Only a stub breather tube sticks out of the top of the block, suitably located for a piping connection in any convenient direction.

Breathing is through two openings in the rear main bearing bulkhead of the crankcase, into a chamber shielded by a semicircular cast wall and covered by the rear cylinder block end plate. Cast passages connect vertically with a generous breather cavity which provides two breather essentials, large cross-sectional area and maximum height. A large air handling capacity, unaffected by operating angle, results by breathing from this central, high crankcase location, which cannot be flooded, and where air rising to the breather exit does not rise past and impede the drainage of oil from some higher section of the engine.

To Order Paper No. 1R . . .
. . . on which this article is based, turn to page 6.

Boeing 707 Jet Sires a Family

Based on paper by

M. L. Pennell

Boeing Airplane Co.

THREE different range versions of the Boeing 707 are being offered the airlines for the purpose of lowering their operating costs. They are designed for intercontinental, transcontinental, and intermediate-range service.

From the airlines' point of view the choices presented by the manufacturers seem to offer ample reason to select different equipment for various portions of their total route structure. There are large savings in airplane-trip cost and even in seat-mile cost if the shorter-range airplane can be selected for at least a portion of the routes. If, for example, the medium-range type could be used on 50% of the routes which required some aircraft with the maximum-range capability, and if the density of traffic on those routes were such that airplane-mile costs were controlling rather than seat-mile costs, overall savings of as much as 12–15% might be realized by the selection of two types of equipment rather than one.

advantages in family design

Varied equipment does raise the question of need for standardization within the airline. But a quick look at costs shows maintenance and training, areas which would be expected to benefit most from standardization, account for only about 8–10% of the total cost. Hence, most of the anticipated savings from the use of a mixed fleet usually will be realized. There are, of course, exceptions. One such would be an airline so small that utilization becomes controlling.

There is a real advantage to an airline in choosing more than one type from a single family. Studies indicate spare parts interchangeability among airplanes in the 707–720 family may run as high as 80%. Such interchangeability would cut down the cost of the spare parts inventory and should be indicative of the kind of savings possible to realize in maintenance, facilities, flight training, and other items.

Fig. 1 presents the results of a very much simplified study of hypothetical airlines having various amounts of medium- and long-range route structure and with different fleet compositions. One curve shows the effect on profit of choosing all large aircraft capable of meeting the maximum range requirement. Another curve shows how much larger a profit is available with a split fleet which is 80% common (where there is a family relationship), unless the line has a predominantly long-range route structure. The third curve shows that, even without this family relationship (zero per cent common), an airline having mostly medium-range route segments should profit by split fleet operation. Again, the size is assumed to be sufficient to make split fleet operation practical. So the airline can prove frequently that it is better off with equipment tailored to do specific jobs than with a single fleet aimed only at the most difficult problem which it has to meet.

cost of design changes

Constant changes in design have a very real impact on manufacture. There are increased costs, both recurring and nonrecurring, of a very large magnitude. Schedules are slowed or made more difficult to meet. Organizational requirements are changed. The manufacturer sets up for a job shop operation rather than for production. Nevertheless, having several airplanes optimized for different jobs contributes significantly to the airlines' ability to meet its own financial problems. And, as far as Boeing is concerned, it is much easier to provide a family of airplanes than a series of completely different aircraft.

A study of the effect of common engineering, common tooling, training, and the like, on the costs of three successive groups of 75 airplanes, each of various 707–720 types, shows the third group to cost only about 55% of what it might have, had it been a completely new design. At the same time, had this third group been of the same design as the original, they

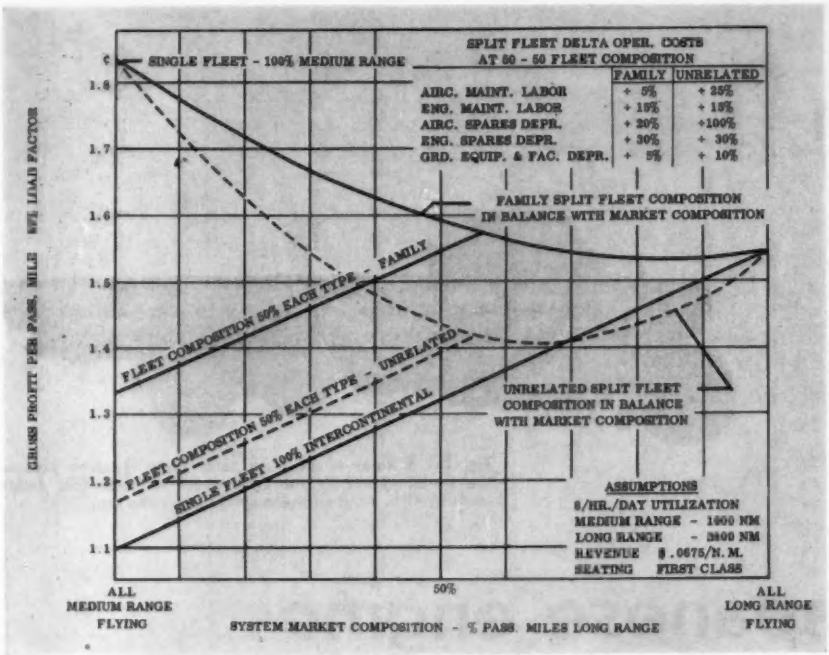


Fig. 1 — Influence of split fleet on airplane profit. Where the route structure has various amounts of medium and long range it pays to operate a split fleet. It pays still better when the fleet is composed of aircraft having a family relationship.

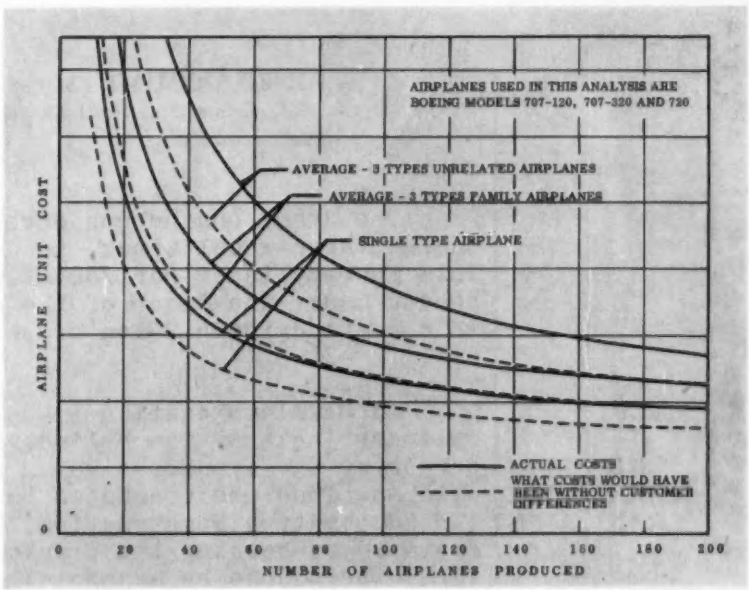

AIRPLANES USED IN THIS ANALYSIS ARE
BOEING MODELS 707-120, 707-320 AND 720
AVERAGE - 3 TYPES UNRELATED AIRPLANES
AVERAGE - 3 TYPES FAMILY AIRPLANES
SINGLE TYPE AIRPLANE
ACTUAL COSTS
WHAT COSTS WOULD HAVE
BEEN WITHOUT CUSTOMER
DIFFERENCES
AIRPLANE UNIT COST
0
0 20 40 60 80 100 120 140 160 180 200
NUMBER OF AIRPLANES PRODUCED

Fig. 2 — Market size and changes demanded by customers both have marked effect on cost of aircraft production. Family types are less costly to produce than aircraft of unrelated design.

would have cost only 40% as much as the first group, so there was still substantial cost to the change.

These costs indicate why the manufacturer must be sure of a reasonable increase in size of market to justify a new type or that illusive break-even point will never even be approached. Fig. 2 shows the effects on average unit cost of increasing quantities of airplanes of the same design, changing from a single design to three types with a family resemblance, or to three completely different types. This chart also shows the effects differences between customer configurations have had on our costs as compared to the originally estimated cost. Here is the situation the manufacturer must face when making a decision to add or not to add a new airplane to the family. And regardless of his decision there remains sufficient risk to keep any manufacturer's gambling instincts more than satisfied.

To Order Paper No. 86B
. . . on which this article is based, turn to page 6.

aluminum and plastic used in japanese engines

Fig. 1 — A three-wheel truck finds favor in Japan because the tax drops sharply for three-wheel vehicles. This design lends itself to a flat engine mounted under the cab.

by JUNZO UOZUMI, *Chief of Research Section, Aichi Machine Industry Co., Ltd. Information for this report was sent by Mr. Uozumi after his recent visit to this country.*

The Giant engine was developed to power a cab-over-engine three-wheel truck, so commonly used in Japan. This four-cylinder horizontally-opposed engine is suspended under the floor of the cab. It supplies 55 hp and is used to drive a 2-ton truck. (See Fig. 1)

ONE PIECE ALUMINUM CRANKCASE

An aluminum casting is used for the crankcase and cylinder jackets. The cylinders have iron liners and the bottom of the crankcase has a steel cover, which forms an oil pan. Thus the crankcase is very rigid because of the closed box-type construction. The rigidity is further improved by keeping the crankcase in one piece (See Fig. 2). This is done by a special center-bearing housing. Before the crankshaft is inserted into the crankcase from the back side, the center bearing housing is fixed to the crankshaft. After insertion, this housing is bolted to a crankcase flange.

SAE LOOKS OVERSEAS

A feature of the SAE Overseas Information Advisory Committee

PLASTIC TAPPETS

The camshaft is under the crankshaft. The tappets are zero-lash and consist of plastic tappets and a coil spring. This construction absorbs the shock of the tappet. Valves are of the overhead type.

The engine is water cooled but uses natural convection. Two up-draft carburetors connect directly with the intake ports, thus avoiding heating the inlet mixture.

ENGINE PERFORMANCE

How two of the Giant series engine compare with similar European engines is shown in the following chart:

Name	BMW R5113	Zundap KS 601	Universal 2B	Giant AE15	Giant AE17
Max Output, hp	24	28	24	46	25
Rpm	5500	4700	4800	4000	5500
Output/Piston Displacement, hp/l (hp/in.^{3})	49 (0.804)	47 (0.771)	41 (0.672)	40.2 (0.659)	47.8 (0.784)
Bore, mm (in.)	68 (2.68)	75 (2.95)	72 (2.83)	90 (3.54)	70 (2.76)
Stroke, mm (in.)	68 (2.68)	67.6 (2.66)	71 (2.80)	90 (3.54)	68 (2.68)
No. of Cylinders	2	2	2	2	2
Piston Displacement, cc (in.^{3})	490 (29.88)	597 (36.40)	578.15 (35.25)	1145 (69.82)	524 (31.95)
Compression Ratio	6.3	6.4	7.0	6.3	7.0
Mean Piston Speed, m/sec (fps)	13.1 (42.98)	11.7 (38.39)	11.5 (37.73)	12.0 (39.37)	12.4 (40.68)
Max Bmep, kg/cm^2 (psi)	7.56 107.5	8.14 115.7	7.7 109.5	9.05 128.7	8.6 122.3

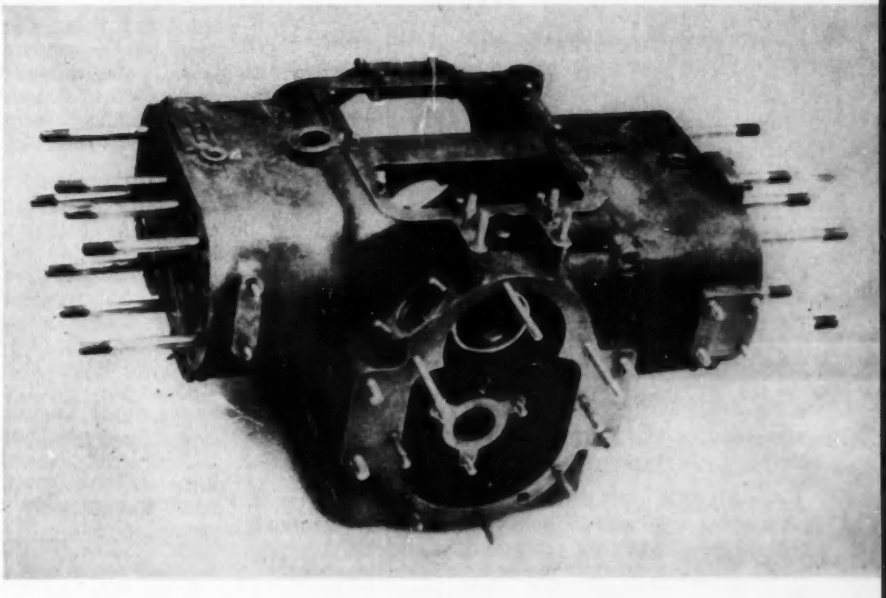


Fig. 2 — A single cast aluminum crankcase adds to the rigidity of the engine (Model AE 34). Wet iron cylinder liners are used. The head is iron and features semi-spherical combustion chambers.

homework for car engineers

Chevrolet's engineer-general manager defines goals for today's car engineering . . . and suggests lines along which problem solutions may be sought.

Based on paper by

Edward N. Cole

Chevrolet Motor Division, GMC

AUTOMOTIVE engineering is a business where you have to run to stay abreast of progress. Our record of progress has been good. But has it been good enough?

There are several areas in which much is still to be done; areas in which defined problems provide the basis for accelerated engineering attack. One of these areas is full of problems inherited by today's engineers from their predecessors; another consists of today's own problems which so far seem to defy the greatest ingenuity and skill of our engineering profession.

engineers inherit problems

Among the inherited problems, seven come to mind for specific comment:

(1) MORE EFFECTIVE USE OF WEIGHT. Better distribution of weight could give better braking and traction characteristics. . . . And for a given size, current cars are simply too heavy.

(2) STRUCTURAL DESIGN of frame and body. So far, sufficient stiffness has been unattainable except by adding excessive weight.

(3) GREATER DIRECTIONAL STABILITY on poor road surfaces and in gusty side winds.

(4) BRAKE PERFORMANCE and reliability in relation to car speed. Recent brake improvements have been significant. But in this and other safety areas, nothing short of perfection is satisfactory.

(5) CORROSION OF SHEET METAL in city traffic conditions.

(6) BODY SEALING against water.

(7) NOISE AND VIBRATION ELIMINATION — including wind noise. Engineering standards in this area are too low. They must be raised.

today's unsolved projects

Today's unsolved problems which stand out as especially worth solving include the following:

BASIC CAR DESIGN should be reviewed to determine if it fills today's needs. Factors to be considered are the greatly changed needs of suburban living . . . the impact of turnpike and expressway type of traffic . . . the coming of the multicar family . . . public reaction to increasing fuel costs . . . and many others.

REDUCTION OF WEIGHT while retaining styling flexibility and maximum safety with substantial reduction in costs is another of today's goals. Specifically: "How do we build ourselves a chassis structure which is stiff enough to eliminate low-frequency shakes, but has good insulation properties against higher frequency noises and vibration?" . . . Our only solution in the past has been to increase weight — a poor compromise.

More use of aluminum has great promise. It is being made available at more nearly competitive prices, and the final end-piece cost often is comparable with iron castings. Effective use of aluminum will be given considerable attention in the years immediately ahead.

BETTER FUEL ECONOMY at road load power is another challenge that should be of great concern

to automotive engineers. We must find a way to accomplish this end. We need to do this to permit retention of the high performance for passing and maintaining speed on grades, without completely sacrificing cruising or low-speed economy.

ELIMINATION OF GEARED TRANSMISSIONS should be sought by development of far more flexible engines with practically constant horsepower down to idle speed. Our automatic transmissions are a rather cumbersome way of overcoming an inherent deficiency of engines. (In a flywheel-driven bus, the Swiss have found a way at least of retaining the energy of their power unit during braking, rather than throwing it away each time.)

FATIGUE DURABILITY OF METALS requires further improvement. In some parts, we have been able to improve the fatigue durability so that we may stress them to cyclic loading up to the yield limits. But for others — such as gears or connecting rods — the permissible stress is much lower. . . . Trouble, of course, is stress concentration. There *must* be some way of using metals so that stress concentrations are less severe, or will dissipate themselves whenever they appear without failure of the part.

Another good question is why our yield and ultimate strengths of metals are limited to a few thousand psi's. In single crystal iron whiskers used in the study of magnetism, scientists have already reached 2,000,000 psi. And, they tell us, there is no reason why cohesive forces of 100,000,000 psi cannot be produced . . . if the atoms are arranged in such regular crystal patterns that the pull or pressure is spread evenly over the entire surface. (Think what this could mean to the life of metals in our modern automobiles!!)

To ELIMINATE OR MINIMIZE THE "DEBUGGING" which plagues every automobile company during the early months of every model changeover is also a vital challenge. Chiefly, it takes work and proper follow-through. Despite extensive laboratory, proving ground, road, and pilot manufacturing tests, engineers have not been able somehow to match exactly the punishment and abuse some people give their cars and trucks. We do a good job. But is it good enough?

To Order Paper No. S123 . . .
. . . on which this article is based, turn to page 6.

Fuels and lubricants are both sinners . . .

. . . when it comes to helping the formation of intake-valve underside deposits of V-8 engines, according to Esso Research cyclic lab tests simulating field operation.

Based on paper by

D. T. Rogers and F. L. Jonach

Products Research Division, Esso Research & Engineering Co.

INTAKE valve underside deposits forming in modern overhead-valve V-8 engines are derived from both the fuel and the lubricant.

With commercial gasolines containing tel, the deposits contain substantial amounts of lead and halogen, which are derived from reactions taking place in the intake system, from blowback from the combustion chamber, and from fuel residues carried by the crankcase lubricant.

The larger intake manifolds used in modern engines and the operation of these engines at a small fraction of the available power provide a greater residence time for fuels in the intake system and thus greater opportunity for decomposition and oxidation reactions to take place. The larger amount of valve lift provides a greater opportunity for blowback from the combustion chamber and exposes the valve underside to high-temperature radiation.

Although all mineral oil crankcase lubricants form intake-valve underside deposits, the rate of formation is generally more rapid with multigraded lubricants prepared from low viscosity base stocks and V. I. improvers, unless the latter are very carefully compounded.

The tendency of lubricants to form intake-valve underside deposits appears to be related to the extent to which the base stock is oxidized at high temperature: the greater the extent of oxidation the more rapid the formation of deposits.

The mechanism by which the lubricant contributes to deposit formation does not appear to involve simple evaporation of the volatile fractions of the base stock to leave a residue of V. I. improver and detergent-inhibitor additives. Instead, it appears that high-temperature oxidation of the lube oil base stock may be the principal source. These reactions appear to be inhibited to some extent by conventional motor oil additives.

There seems to be some interaction of fuel and lubricant, but it is not known whether this is a chemical interaction or a physical mechanism in which the lubricant and its oxidation products act as a binder for the fuel products.

The quantity of deposits formed with a particular fuel-lubricant combination is a function of the quantity of lubricant which reaches the valve underside area. In the range of flow rates studied, increasing the flow rate of the lubricant to the rocker arm area increases the rate of deposit formation. Increasing inlet air temperature likewise increases deposit formation.

Since lubricating oil contaminants contribute to intake-valve deposit formation, a definite advantage is indicated for the use of oil filters and frequent oil changes.

To Order Paper No. 106C . . .
. . . on which this article is based, turn to page 6.

Ground-Level Escape System Found Practicable

. . . Martin-Baker escape system permits ejection at altitudes below 1000 ft through use of a high trajectory.

Based on a paper by

F. P. Marciniak and R. A. Houghton

Grumman Aircraft Engineering Corp.

LOW-LEVEL pilot ejection by a Martin-Baker seat has been approved by tests run at Grumman for the U. S. Navy. The Mark 5A forcibly speeds up the deployment of the parachute after ejection below 1000 ft. Successful ejections were made by Grumman at ground level in their F9F-8T jet trainer at speeds of 95–450 knots.

components of seat

The Martin-Baker seat consists of the seat assembly, ejection gun, parachute pack, duplex drogue chute, drogue gun, time delay mechanism, *g* limiter, barostat, and automatic leg restraint (Fig. 1).

The seat structure is composed of a framework of two sides beams which support the seat pan, drogue gun, drogue chute container, *g* switch, and barostat. Mounted on the inside of these beams are three pairs of slippers which slide into guide rails mounted on the external cylinder barrel of the ejection gun. Three cross-members bridge the arrangement.

Three tubes make up the telescoping ejection gun. The outer tube remains fixed in the cockpit, attached top and bottom. Firing of the primary power charge forces the inner and intermediate tubes to rise as a consequence of the generated gas pressure. As the gun extends, it uncovers two ports exposing and flame-firing the two auxiliary charges, the first after 14 in. of extension, the second after a total of 31 in. After further movement, the intermediate tube is stopped by a flange on the barrel, the shock being cushioned by 12 gas-filled pressure rings. The inner tube continues to rise, carrying the seat until it leaves the intermediate tube. At the separation point, the seat has traveled a total distance of 77 in.

The duplex drogue system is comprised of a 15-oz slug attached to two drogue parachutes. Connected in tandem, the parachutes are fastened to a scissor-shackle at the top of the seat. The slug is housed in a gun on the left side. The controller drogue (18 in. diameter) and the main stabilizer (60 in. diameter) drogue are stowed in the same container. Four flaps, situated at the top of the container, protect the drogues and hold them in position. The uppermost part of the container has metallic protrusions which are used as canopy breaker points when the pilot ejects through the cockpit canopy. In addition to storing the drogue system, the container houses the face curtain and firing mechanism.

The main parachute employed is a standard Irvin

IN AN ARTICLE appearing in the November Journal, Donald M. Root of Northrop Aircraft discussed the factors in selection and design of escape systems for supersonic aircraft, evaluating five different methods.

In the October Journal, A. I. Beck and G. Hildebrand described progress made at Republic Aviation Corp. in extending the usefulness of the open ejection seat escape system.

On these pages, the Martin-Baker ejection seat Mark A5, recently tested by Grumman on their F9F-8T jet trainer, is described.

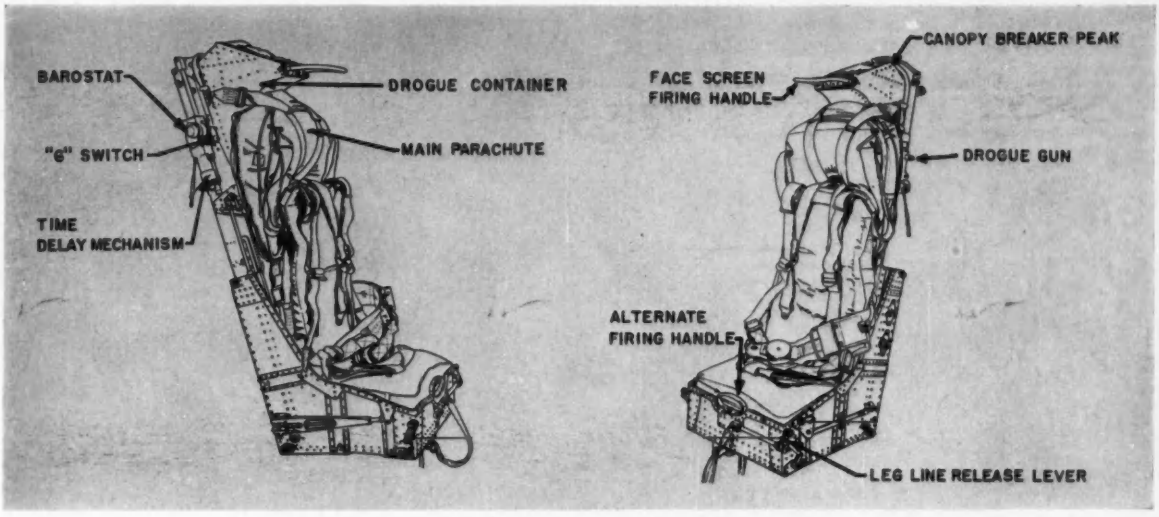


Fig. 1 — Martin-Baker Mark A5 ejection system.

24-ft diameter flat circular-type canopy. This is stored in a fabric container having the shape of a horseshoe. This shape permits the shoulder harness straps to pass beneath the arch of the horseshoe into a lock on the seat, thereby leaving the greater part of the canopy stowed above the arch and free for clean extraction. The assembly of this pack is secured to the seat back structure by two restraining straps.

The time delay mechanism delays the deployment of the main parachute until the seat has been stabilized and retarded by the drogues. The delay required by the drogues to slow the seat is dependent upon the speed at which ejection occurs. At low speeds the delay required to ensure safe, practicable ejection from ground level is approximately 1½ sec. This, however, is not acceptable at high ejection speeds where the delay must be greater to prevent excessive opening speeds for the main canopy.

Fitted to the time delay mechanism is an automatic *g* switch which is sensitive to the deceleration imposed by aerodynamic drag. Should decelerative loads be greater than approximately 6 *g*, the device will not permit the main parachute to deploy. When the loads have been reduced below 6 *g*, safe separation and deployment of the main parachute are attained. At altitudes below 10,000 ft, the main parachute will be deployed approximately 1.3 sec after initiation of ejection plus the time that the system is subjected to normal load factors greater than 6. Upon ejection at heights above 10,000 ft, the barostatic control prevents the operation of the delay mechanism until the seat and pilot have fallen to an altitude of approximately 10,000 ft. This reduces prolonged exposure to low-temperature and rarified air. During the descent, the seat is stabilized by drogues and the pilot is supplied automatically with emergency oxygen.

The automatic leg restraint is a single reinforced nylon cord, one end of which is connected to the cockpit floor by a roller bracket. The other end is passed over a roller to a snubbing unit on the underside of the seat pan, and then through metal rings on the calf straps, which the pilot wears just below his knees. As the seat is ejected from the aircraft, the nylon cord becomes taut, holding the legs against the forward edge of the seat pan. Additional load due to further displacement of the seat breaks a shear pin on the terminal fitting, separating the cord from the cockpit floor. The one-way snubber unit assures restraint of the legs to the front face of the seat pan after the nylon cord separates from the cockpit floor.

If the automatic gear fails to operate at any point after ejection, the personnel parachute is released from the drogue parachutes by the slide-disconnect D-ring on the harness, the pilot is released from the seat by a manual override lever, and the personnel parachute is deployed by the main parachute rip chord D-ring. The main parachute is equipped with a pilot chute, which is of use only in the manual chute deployment. If the seat fails to eject and bail-out over the side is necessary, the same procedure is followed.

sequence of ejection

If escape is necessary in flight, one action by the pilot initiates the ejection — a pull on the face curtain firing handle or the alternate firing handle located on the front of the seat pan. This action ignites the primary charge, accelerating the pilot upward relative to the aircraft. The initial movement of the seat triggers the time delay mechanism, which fires the drogue gun ½ sec after ejection initiation. The drogue projectile extracts the controller drogue from its stowage. A nylon cord between the controller and the main drogue allows the controller drogue to be fired clear of the seat wake. This cord slightly delays extraction and opening of

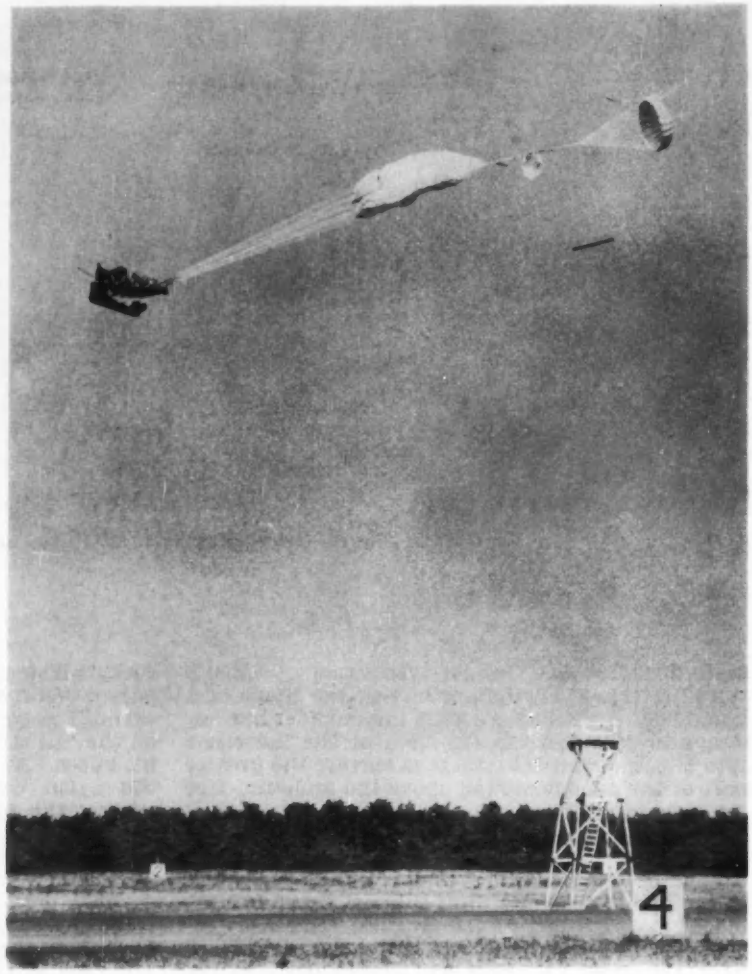


Fig. 2 — Free flight of the Mark A5. The seat rotates free of the pilot while the drogues pull out the main canopy.

Ground-Level Escape System Found Practicable

. . . continued

the main drogue, in order to apply the deceleration progressively. The first drogue, when deployed, starts to stabilize and decelerate the seat at the same time that it controls the opening of the main drogue.

Decelerative loads are transmitted to the seat from the main drogue by the scissor shackle located at the top of the seat. Initial seat movement also arms the main parachute time delay mechanism. After adequate stabilization and deceleration by the drogue chutes, the time delay mechanism opens the scissor shackle, freeing the drogues from the seat. Simultaneously, a mechanism releases the seat harness, the parachute pack restraining straps, and the leg restraint line. Operation of all of these devices releases the pilot from the seat and permits the main chute to be pulled from its container, the chute's drag lifting him out of the seat. The seat then free-falls to earth while the pilot descends supported by his parachute. Fig. 2 shows the seat beginning to rotate free of the dummy while momentarily restrained by the lap belt sticker clips. As they are released, the drogues act as pilot chutes and pull out the main canopy.

Results of tests at Grumman have qualified the Mark 5A for installation in production F9F-8T aircraft. With this system the proportion of successful ejections below 1000-ft altitude should improve. And many pilots who heretofore would have elected to crash-land or ditch the aircraft (with fatal results) can now safely eject.

To Order Paper No. 91A . . .
. . . on which this article is based, turn to page 6.

Glass Still Lacks Structural Dependability

Based on paper by

George B. Watkins
Libbey-Owens-Ford Glass Co.

GLASS as manufactured today, whether regular (annealed) or automotive safety glass (heat strengthened and laminated), fails to meet the strength properties generally required of structural materials. Other factors such as surface abrasion and weathering reduce the ultimate strength of glass making it still more unreliable as a structural member. It is foreseeable, however, that continued research will produce a transparent material which when laminated with glass will result in a composite capable of functioning as a structural member.

Results of laboratory tests made on monolithic samples of both annealed and tempered glass specimens show the following:

bending and uniform pressure tests

The wide spread in values for modulus of rupture and uniform pressure loads obtained on identically prepared specimens of annealed and tempered glass makes it difficult to predict the breaking stress of any individual sample.

glass fatigue

A decrease in the breaking stress of glass as the time of load application increases emphasizes a degree of uncertainty about the reliability of either annealed, tempered or regular laminated glass under load.

strength versus temperature

The resistance to bending of annealed and tempered glass increases with decreasing temperatures from approximately 500 F to – 75 F.

temperature stability of tempered glass

The prestressed state of tempered or heat-strengthened glass is not stable at temperatures of 600 F and above as shown by stress measurements and modulus of rupture determinations. The rate of stress release increases with increasing temperatures.

surface damage

The wide variation in the strength of similarly prepared glass specimens is explained in part by the presence of microscopic cracks or fissures in the glass surface as manufactured. Lending support to this theory is the material decrease in the resistance to bending and uniform pressure loading of annealed and tempered glass specimens previously damaged from sandblast abrasion.

developments for the future

Edge constructions to increase the tensional load capacity of laminated glass are being investigated. In some instances, auxiliary attachments have been made by cementing or bonding flexible materials to the marginal edge of glass plates to further reinforce and stabilize metal-reinforced offset edge construction.

In general it can be said that any edge construction used for glazing glass composites that places the marginal edge of the glass plates in tension is less dependable than one which makes use of the extended portion of a less brittle material bonded to the glass surfaces, thereby distributing the tensional load over the entire glass area.

A more ideal edge construction awaits the development of a transparent material to serve as an interlayer for a glass composite; the marginally extended interlayer to have sufficient mechanical strength and temperature stability for dependable tensional and compressional loading and provide means for joining sections and frame for mounting or glazing.

The realization of such a development in composite glass would make possible a transparent body having a minimum of opaque areas for the modern automobile.

To Order Paper No. 11R . . .
. . . on which this article is based, turn to page 6.

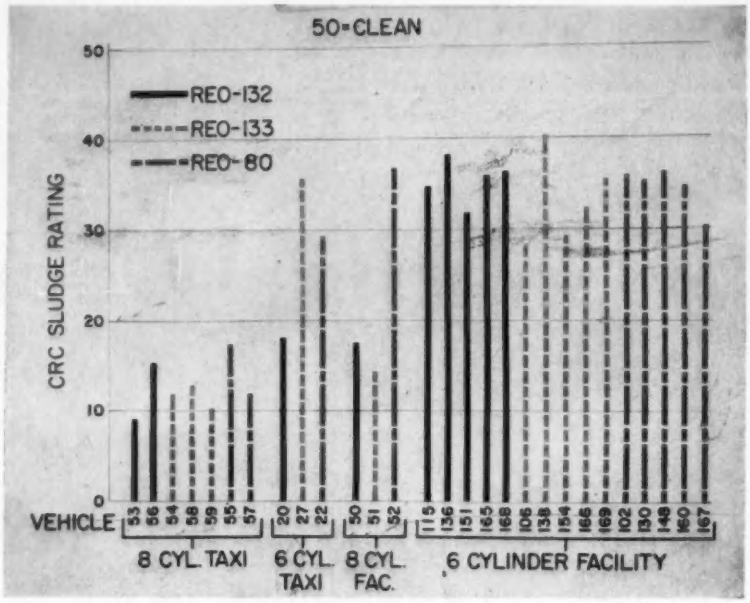


Fig. 1
SLUDGE RATINGS for vehicles used in test.

Polymeric-Dispersants

Don't Always Prevent Sludge

Based on paper by

C. F. Schwarz and H. T. Cline
U. S. Army Ordnance, Aberdeen Proving Grounds

POLYMERIC-DISPERSANTS, as a class, are not necessarily effective in preventing engine sludge deposits, if the severity of recent tests on post vehicles at Aberdeen Proving Ground are typical.

In the past five years, much has been claimed for, and expected from, these ashless-type detergent-dispersants as a means of retarding formation of low-temperature sludge deposits. These claims are supported by results of FL-2, EX-3, and modified EX-3 tests and by results from field tests. However, the repeatability and reproducibility of lab tests — and the degree of correlation between lab and field tests so far published are not yet acceptable to the Ordnance Corps nor, it is suspected, to the petroleum industry.

In these recent Aberdeen tests (which were a part of a cooperative Coordinating Research Council Fleet Test program), 28 standard 1956 vehicles of a single make were used as the test facility. All the vehicles were new. There were ten V-8 sedans; three 6-cyl sedans; and fifteen 6-cyl, ½-ton trucks. Each vehicle had a 3-speed manual transmission. Each engine contained a thermostat which functioned at about 150 F. Two types of filter elements (each from one production run) were saturated with fresh test oil and weighed before they were installed in the engines.

Three oils used to lubricate the fleet, identified by CRC's code numbers, were REO-80, REO-132, and REO-133. No effort was made to get a special fuel for the test.

All vehicles were operated in their normal assignments — which were excellent examples of continuous low-temperature, single-performance operation.

After 18 months and 14,000 miles of operation, without major failure or accident, the tests were stopped.

Sludge ratings were made on seven engine parts of

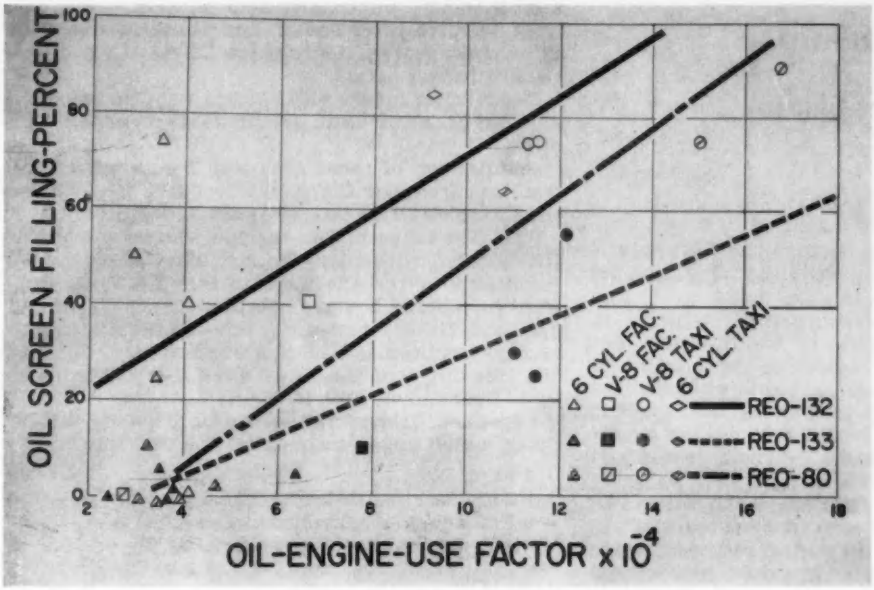


Fig. 2
LEAST OIL SCREEN PLUGGING was observed in engines using oil with CRC code number REO-133.

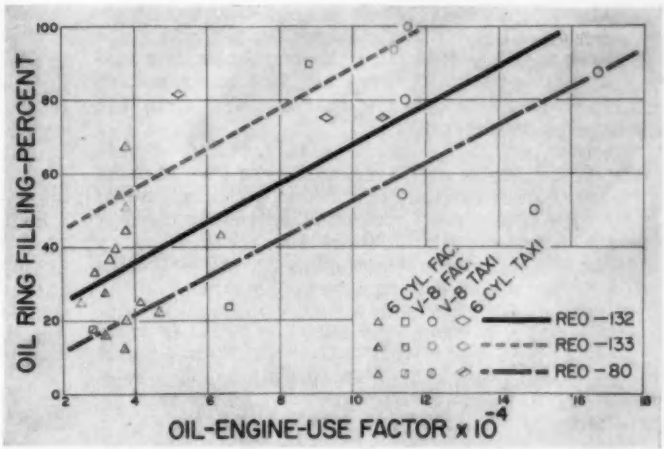


Fig. 3
OIL RING FILLING in Aberdeen tests was least with REO-80; greatest with REO-133.

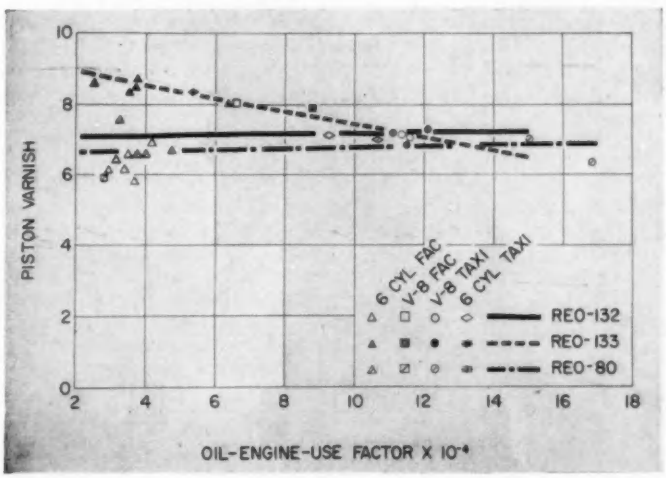


Fig. 4
VARNISH on piston skirts was about the same regardless of the oil type used.

Polymeric-Dispersants

Don't Always Prevent Sludge

. . . continued

the 6-cyl engines; on eight parts of the V-8 engines. CRC merit rating procedure was used. Fig. 1 shows the sludge rating for each vehicle.

If the average sludge rating for all vehicles on each oil are compared, little or no difference between oils is found with respect to the amount of sludge deposited in the engines. This was in direct contrast to results of fleet tests made in Cleveland by Albrecht, Potter, and Hyatt.[1]

Least screen plugging was observed in the Aberdeen engines using REO-133 . . . and most plugging occurred in engines using REO-132, as shown in Fig. 2. As much as 90% of the area of some screens was restricted when the vehicles were rated. But there was no indication of low oil pressure during the final days of the tests.

Oil ring filling (Fig. 3) was rated visually, because deposits would be disturbed in removing the rings. Least filling of the 3-piece "picket fence" type rings occurred with the REO-80 oil and greatest ring filling with the REO-133. The oil that was worst in filling oil rings, in other words, was best from the standpoint of screen filling.

There was little difference in the amount of varnish on the piston skirts, regardless of the oil used. (Fig. 4) Varnish seemed to increase with engine-oil-use factor in engines lubricated with REO-133, but the other two oils did not show this trend. In every vehicle, the varnish ratings were no worse than a No. 6 rating, which is comparatively clean.

Rusting — which was defined as black stains not soluble in 50% phosphoric acid solution — was confined to valve-lifter bodies, and plungers and stems of exhaust valves. Only three lifters stuck during the entire test period.

Deposits on intake valve tulips was the same, regardless of the oil used, the engine type, or the operation.

Comparison of these Aberdeen results with those resulting from the Cleveland fleet test (also part of the CRC Fleet Test program) are shown in Fig. 5.

This plot suggests that the operating conditions of the Aberdeen fleet were more severe than operating conditions of the Cleveland fleet. Yet both fleets were considered to have operated under continuous low-load-factor, light-duty, low-temperature, stop-and-go conditions. The plot suggests that different oils, like different gasolines, have different sensitivity to operational severity.

Possible differences in operation between the two fleets, which might account for the differences, are:

- Fuel.
- Engine temperature.
- Frequency of cold starts.
- Warmup and cool-down periods.
- Deposit settling as influenced by length of inactivity of the engine.
- Contamination level of oils as influenced by oil economy of the engine.

If a laboratory test is to be used as a yardstick for evaluating the low-temperature performance of oils, it must either recognize and simulate the severity level of low-temperature field operation, or be designed to a severity level which satisfies some acceptable per cent of vehicle operation.

Since result between these two sets of tests show wide differences in degree of operating severity, the question arises as to which degree of severity is the more typical. If the degree of severity of the Aberdeen operation is at all typical, then we are led to the conclusion indicated at the beginning of this article: that polymeric dispersants, as a class, are not necessarily effective in preventing sludge deposits in an engine.

To Order Paper No. 106D . . .
. . . on which this article is based, turn to page 6.

[1] "Stop Sludge and Go Clean," by R. H. Albrecht, R. I. Potter, and K. Hyatt. SAE Transactions, Vol. 64, 1956, pp. 751–774.

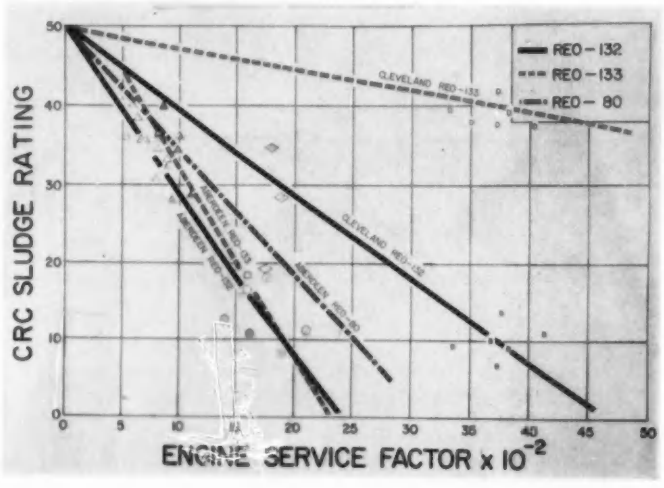


Fig. 5
COMPARISON between recent Aberdeen fleet tests and Cleveland fleet tests suggests that the Aberdeen fleet faced more severe operating conditions. (Both field tests were part of a Cooperative Research Council Fleet Test program.)

How electrical system designers are meeting passenger-car demand for . . .

More Performance per { lb / sq in.

Based on paper by

D. C. Redick

Delco-Remy Division, GMC

GENERATOR, regulator, battery . . . and ignition system designs have been constantly modified to handle the electrical load on passenger cars, which has doubled since 1952. Then only 295 w were required of a generator, as against 590 w demanded by 1958's average car. Required to stay in the same sized packages, generator designs are currently being readied to meet an expected 800-w-or-more demand. The new designs will produce 33½ w per lb, as against 21.7 w per lb for the 1959 units, 15.9 for the 1954 units . . . and 4.8 w per lb back in 1925.

higher speed generators

On generators, the number of armature turns has been decreased from four to three and the generator turned at a higher speed. These latest moves were made to meet the recently accelerated, as well as the ever-increasing, demand for greater generator output from a unit of given size and cost. And making these moves involved specific design challenges.

Keeping the armature conductors in the slots at 14,000 rpm, for example, was a real problem. The rope wedge was unsatisfactory; the high centrifugal forces of the conductors would push the ropes out of place, and consequently ruin the machine. . . . Two rope wedges, staked into place, one at each end of the slot, combined with a tougher varnish turned out to be the answer . . . and better cooling of the slots was a significant byproduct of this solution.

Then a separate fan — made from a quarter-hard sheet stock — and a separate pulley were incorporated in the designs to get away from the shedding of blades at these new high speeds by the old 2-piece integral fan. (10,000 rpm had been considered an absolute maximum in previous generator designs.)

Bearing improvement wasn't much of a problem. It just cost money. The sleeve bushing was replaced with a 17-mm ball bearing.

Also, the electrical performance throughout the 1500–2500 rpm range was bettered by increasing the field coil strength and thus providing more flux for the armature windings to cut. Field coils consuming 3½ amp were needed.

how regulators are tempered

To up the flow of current through the regulator's pair of vibrating contacts — which limit how much field current can be used — has been a major aim in recent regulator design. This aim was achieved in the last year or two when this flow was increased from the 2 amp that previous passenger-car regulators would handle, up to the 3½ amp now needed. At the same time, regulator life was increased two to three times. (Truck-type regulators handle 3½ amp satisfactorily, but are too costly to be considered for passenger cars.)

These combined improvements in generator and regulator produce a system which gives more performance in the low-speed range as well as an increase in maximum output of 30% . . . all in the same sized package.

battery plates get thinner

Continued development of thinner plates and thinner separators have brought today's battery to a point where it can produce 57 w-min per lb of weight . . . without increasing the size. (In 1954, the battery produced only 35 w-min per lb . . . very little more than the 32 of 1925.)

Still thinner plates and thinner separators are in the making to meet the sure demand for more battery power to meet tomorrow's still greater cranking requirements. Thickness of the rubber case is probably going to be reduced, too.

new ignition concept due

To meet the future heavier demands on ignition, a new concept known as the pulse ignition system will soon replace the coil now used in the conventional units.

The distributor will still be used to trigger the chain of events which takes place in the ignition system. But the breaker points will carry less current than in today's system. In the new system, a cold cathode switch tube breaks the higher current, with the net result that spark-plug voltage builds up fast enough to a high enough value to fire fouled spark plugs.

Of course, if fuels and additive are developed to minimize spark-plug fouling when a 13/1 compression ratio becomes common, a less complicated ignition system might be used. . . . A unit using semiconductors to handle higher breaker current could be employed.

To Order Paper No. S114 . . .
. . . on which this article is based, turn to page 6.

4-Way Exhaust V-8—Turbocharger

Based on paper by

Harvey A. Cook

Thompson Products, Inc.

COMPUTER ANALYSIS of the matching of a turbocharger to a V-8 diesel engine reveals:

1. Four-way division of the exhaust on the V-8 engine is desirable for obtaining good matching of turbocharger to the engine.

2. Two-way division of exhaust (effectively two 4-cyl engines) appears to accomplish none of the improvement in matching that results by using the four-way division to reduce the increase in turbocharger pressure ratio with increase in engine rpm.

3. Two-way division of the exhaust of the V-8 engine by separation of the right bank and left bank for turbocharging is not recommended.

4. Practical four-way division of the V-8 diesel greatly reduces the effect of one cylinder upon the scavenging of another and is recommended where a four-way division of exhaust is desired.

5. Different V-8 engines may be expected to show various degrees of improvement in matching using the recommended divided exhaust flow systems due to differences in valve timing.

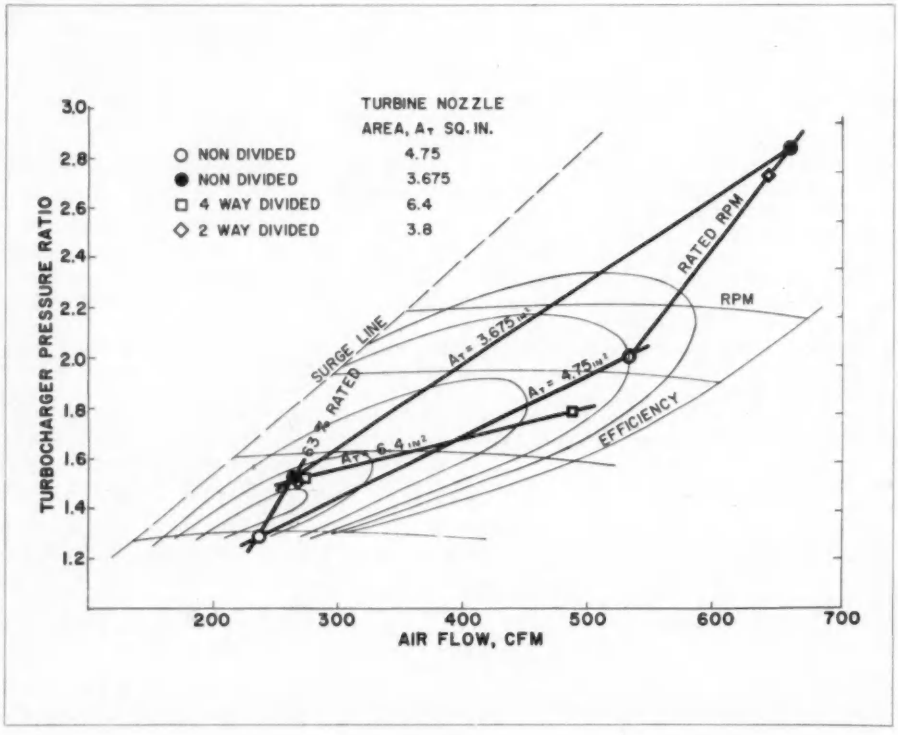


Fig. 1 — V-8 diesel pressure and air flow with various exhaust manifolds.

Improves Matching

6. Results on 4-way and 2-way divided V-8 engines indicate that 4-cyl engines would be improved by division into pairs of cylinders.

Adapting a Turbocharger to the Exhaust of a V-8 Diesel Engine

Computer analysis of the V-8 diesel engine cycle with turbocharger was made to show the effect on matching of dividing the exhaust in various ways. (Matching of a turbocharger to an engine is here considered as the determination of the best configuration of exhaust division and the proper nozzle area to give the desired engine performance over a speed range of about 60–100% rated speed and not exceed recognized temperature and pressure limits.)

The firing order of V-8 engines is determined by crankshaft design and vibration considerations. To achieve various divisions of the exhaust, the practicability of the manifold and ducting must be considered. Let us consider the following types of exhaust manifolding:

1. Nondivided.
2. Division into effectively two 4-cyl engines.
3. Practical four-way division.
4. Division of right bank from left bank.

The nondivided and division of left and right banks of cylinders are generally considered because of the simplicity of manifolding. The effective division of the engine into two 4-cyl engines, with the same even firing sequence in each, is possible by joining a pair of cylinders from one bank with the appropriate pair from the other bank. In this way a two-way divided turbocharger may be used. The further division of these cylinders to effectively divide the two 4-cyl groups into four pairs of cylinders is not feasible with this type of manifold because paired cylinders from each bank fire successively.

A practical four-way division of the exhaust is considered which will allow the use of two turbochargers with a two-way divided turbine housing (one on each side of the engine) or a single four-way divided turbocharger. The cylinders from each bank are paired such that a minimum of two other

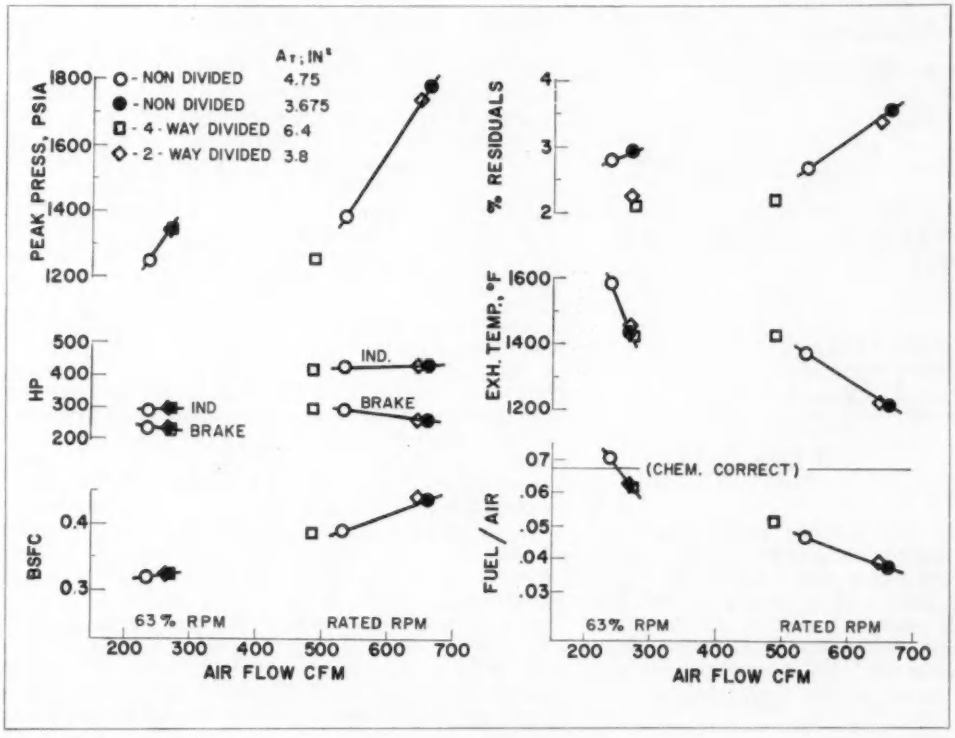


Fig. 2 — Engine performance with various exhaust manifolds on a V-8 diesel.

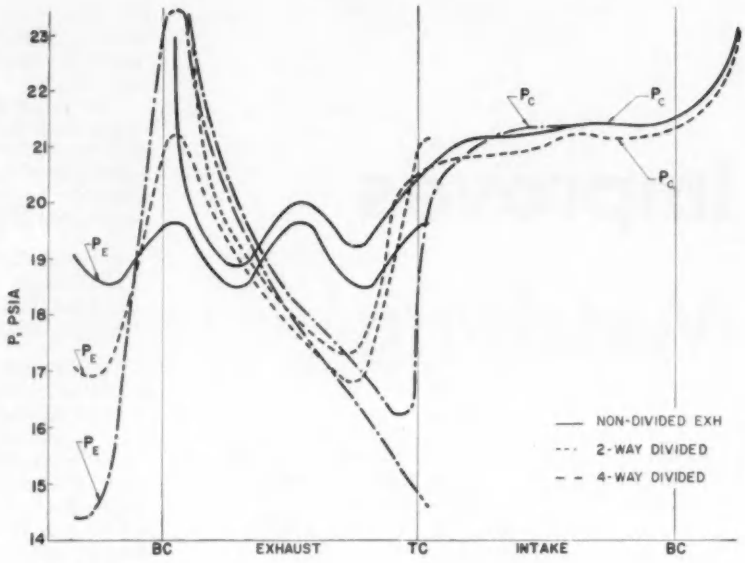
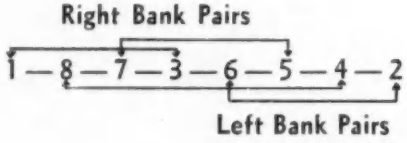


Fig. 3 — V-8 diesel exhaust cycles, 63% rated rpm. (P_E = exhaust pressure; P_C = cylinder pressure)

4-Way Exhaust Improves V-8–Turbocharger Matching

. . . continued

cylinders fire between the cylinders of each pair. This grouping of cylinders for a 90 deg V-8 engine firing order is shown in the following diagram:



The practical four-way division is a logical step in the direction of approximating the ideal division where three other cylinders fire between firing of each cylinder of a pair. As indicated before, the ideal four-way division would require an elaborate cross-over exhaust manifold and is therefore considered impractical except for V-8 engines with exhaust ports on the inside of the V, which is an uncommon arrangement.

Results and Discussion On V-8 Exhaust Utilization

The pressure ratio and air flow in cfm for various operating conditions are presented in Fig. 1 on a typical turbocharger compressor map. The differences in operation at rated rpm and 63% rated rpm are clearly shown for the nondivided V-8 with turbine nozzle areas of 4.75 and 3.675 sq in. and for the four-way and two-way divisions of the exhaust flow to the turbine. The pressure ratio of 1.52 at 63% rated rpm with the 3.675 sq in. area nondivided turbine was used as a basis for comparison of the four and two-way division exhaust, because the air flow was adequate to burn the amount of fuel intended to be burned at 63% rpm. Note, comparison of divisions of exhaust starts with equal compressor pressure ratio, at this engine rpm, by proper selection of turbine nozzles.

The fuel-air ratio and other pertinent data for the same operating points shown in Fig. 1 are presented in Fig. 2. Note, that the fuel-air ratio at 63% rated rpm with the 4.75 sq in. turbine nozzle is above the chemically correct fuel-air ratio and therefore constitutes an unrealistic operating condition. Although operation with a nondivided turbine with the smaller turbine nozzle is feasible, the increase in pressure ratio upon going from about 63% rated to rated rpm is high (87% increase) whereas a much smaller increase is shown for the four-way division (17%). The two-way division is only slightly better (81%) compared to 87% for the nondivided.

The advantage of using the lower pressure ratio afforded by the four-way division of the exhaust is reflected in the lower peak cylinder pressure. Comparable operation in all respects is obtained at 63% rated rpm with generally improved performance

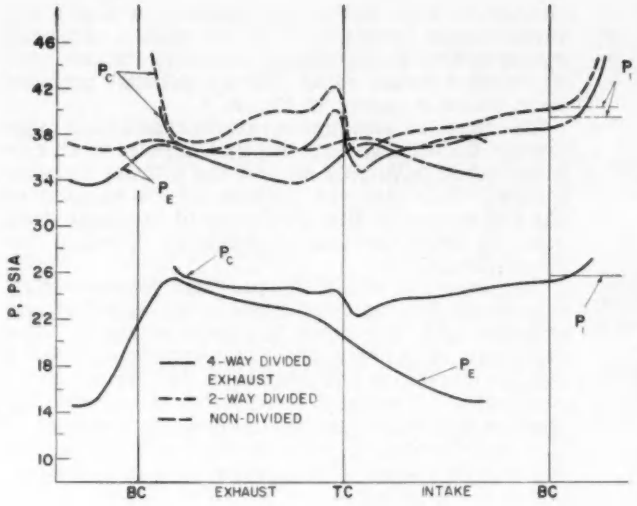
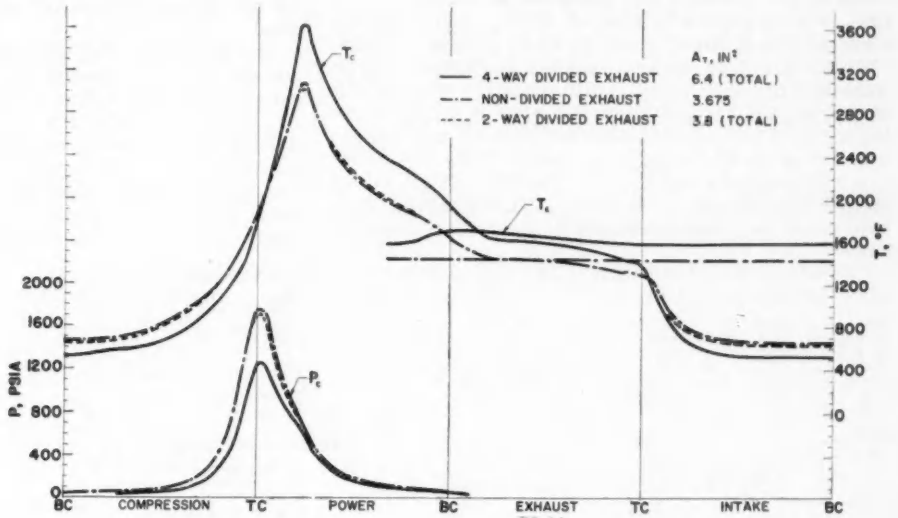
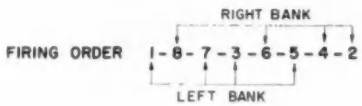


Fig. 4 — V-8 diesel cycles at rated rpm. (T_C = cylinder temperature; T_e = exhaust temperature; P_C = cylinder pressure; P_e = exhaust pressure; P_i = intake manimold pressure)





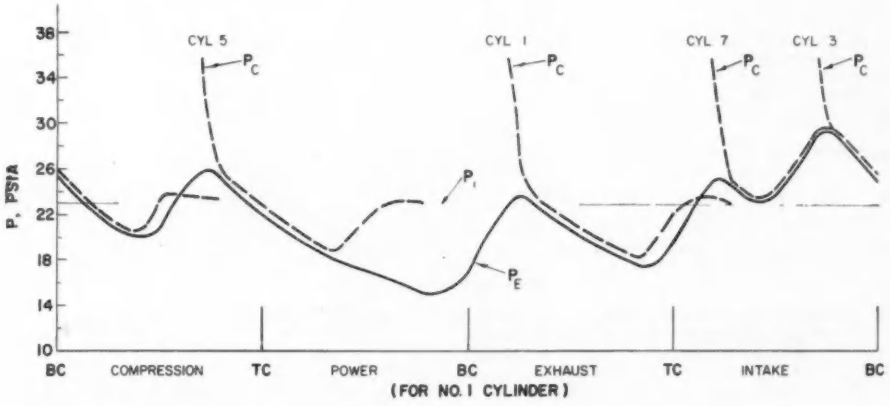


Fig. 5 — Uneven pressure in exhaust manifold for one bank of a V-8 diesel. (P_C = cylinder pressure; P_e = exhaust pressure; P_i = intake manifold pressure)

4-Way Exhaust Improves V-8–Turbocharger Matching

. . . continued

with the four-way division at rated rpm. These data clearly show that four-way division of the exhaust on the V-8 engine is desirable for obtaining a good matching of turbocharger to the engine.

Fig. 3 shows the differences in the exhaust pressure cycles for the nondivided, four-way divided and two-way divided turbines at 63% rated rpm. The resulting lower cylinder and exhaust pressure during scavenging accounts for the per cent residuals being less with the divided turbine. Fig. 4 presents similar cycle data for operation at rated rpm. The same characteristics are observed as for the lower rpm, but operation is now at different inlet pressures as determined by the divisions of the exhaust.

Because actual engine friction horsepower data were not available, the relationship of bhp to ihp shown in Fig. 2 is only approximate. A trend of the higher pressure ratio turbocharging to cause friction horsepower to increase faster than the indicated horsepower increases is evident. This is but another reason for using as low a turbocharger pressure ratio as is consistent with the engine application.

The simplicity of collecting the exhaust from each bank of cylinders and using a single entry turbocharger on each side of the engine or a dual entry turbocharger at the back of the engine has been considered by many engine designers. These configurations result in an uneven exhaust pressure cycle which is shown in Fig. 5.

The effect on scavenging various cylinders is quite drastic, the analysis showing that number seven cylinder would have only 69% of the average cylinder airflow. This two-way division of the exhaust of the V-8 engine by the separation of the right bank and left bank for turbocharging is therefore not recommended.

The degree to which the practical four-way division suggested herein minimizes the effect of one cylinder upon the other is shown in Fig. 6. The blowdown of the exhaust of number one cylinder is nearly complete before number three cylinder starts exhausting. Number three cylinder has about 2.5% less air flow than number one cylinder because of the slightly higher exhaust pressure during the scavenging period. The practical four-way division of the V-8 greatly reduces the effect of one cylinder upon the scavenging of another and is recommended for use where a four-way division of exhaust is desired.

The results of this analysis are indicative of the advantages and disadvantages of dividing the V-8 exhaust in various ways. Different engines having various degrees of valve overlap and different valve timing should be expected to show similar results to those discussed herein. The advantage shown for the four-way divided V-8 over the two-way indicates that a 4-cyl engine would be improved by division into pairs of cylinders.

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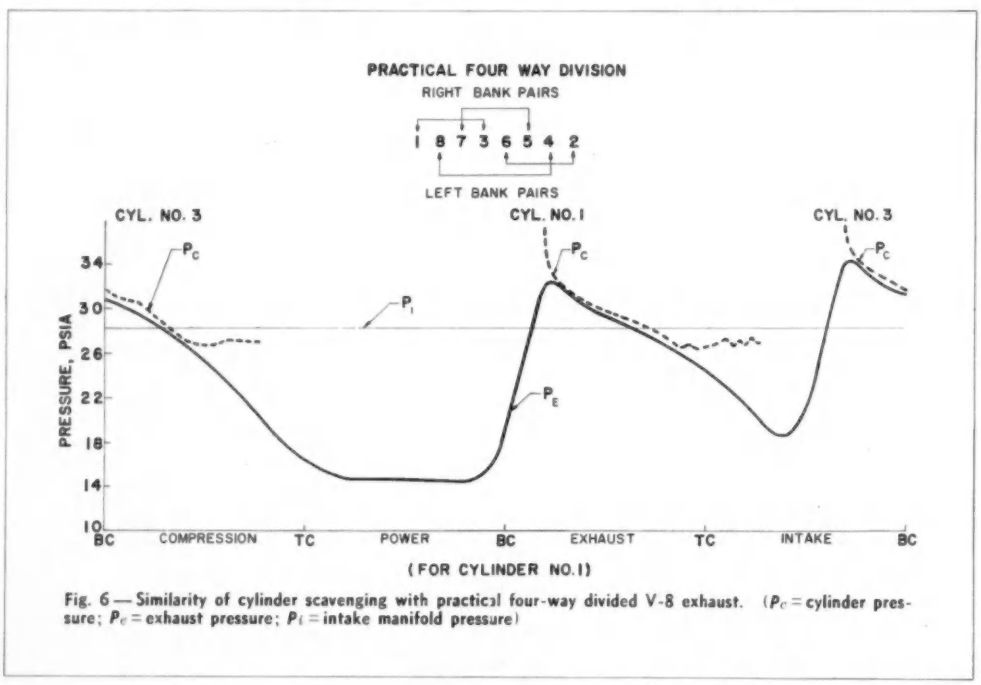


Fig. 6 — Similarity of cylinder scavenging with practical four-way divided V-8 exhaust. (P_C = cylinder pressure; P_E = exhaust pressure; P_I = intake manifold pressure)

–80 to +300 F Vibration Isolators Possible with BTR Elastomers

Based on paper by **G. W. Painter** Lord Mfg. Co.

. . . new broad temperature range elastomers have extended the useful range of isolators and provide low resonance magnification as well.

BROAD TEMPERATURE RANGE elastomers have extended the useful range of vibration isolators from – 80 to + 300 F. Previously, low-temperature stiffness and insufficient internal friction had limited the application of this type of isolator when natural rubber was used. With the BTR material, a resonant magnification between 2 and 3.5 can be held over the temperature range.

The dynamic properties of BTR, however, do vary widely in the temperature range when the frequency and dynamic strain are varied.

The resonance magnification of an isolator can be found in terms of G'/G'', where G' is the elastic component of the dynamic shear modulus and G'' is the damping component (and 90 deg out of phase). Figs. 1 and 2 show the effect on G'/G'' of temperature, frequency, and dynamic strain.

The resonant magnification is given by

$$\frac{x_o}{a_{o\,(res)}} = \sqrt{1 + \left(\frac{G'}{G''}\right)^2}$$

where:

x_o = Total displacement of part being isolated
a_o = Total displacement of supporting structure

In a conventional linear spring and dashpot system, the corresponding equation is:

$$\frac{x_o}{a_{o\,(res)}} = \sqrt{1 + \left(\frac{k}{c\omega}\right)^2}$$

where:

k = Spring constant
c = Damping coefficient

The test results shown in Fig. 1 are for a constant dynamic strain of ± 0.01. From Fig. 2 it can be seen that the whole curve of G'/G'' in Fig. 1 would move down if a higher strain had been used.

Since high strains are typical of operation at resonance, the low values of G'/G'' in Fig. 2 are typical of the resonance magnification of BTR elastomer isolators.

At – 80 F, the elasticity (G') of a BTR elastomer is a little more than twice its value at room temperature. Natural rubber, on the other hand, would be almost ten times as stiff at – 50 F as at room temperature. (See Fig. 1.)

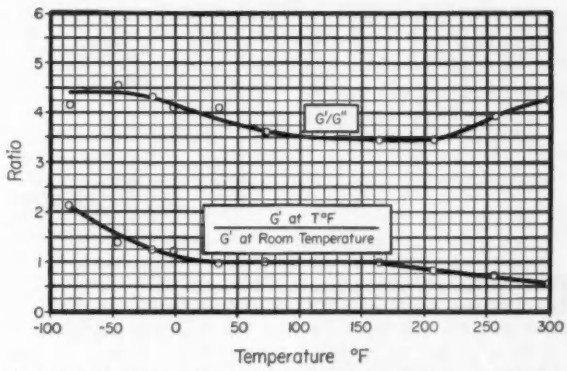


Fig. 1 — Temperature has little effect on resonance magnification, G'/G'', of a Broad-Temperature-Range elastomeric isolator. Damping modulus, G'', decreases continuously with increasing temperature. However, due to the rapid rise of the elastic modulus, G', with decreasing temperatures, the BTR material is slightly more "lively" at low temperature than at room temperature.

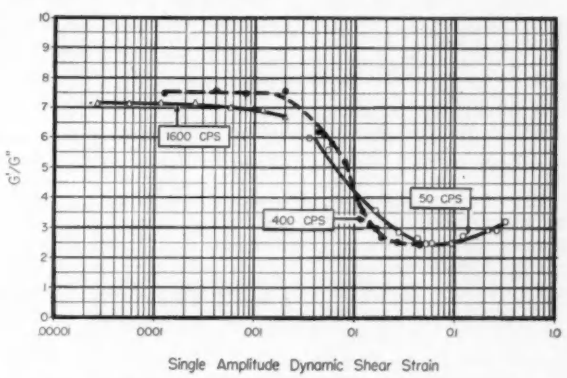


Fig. 2 — Major variations in BTR elastomer performance occur with changes in dynamic strain — and, to a lesser extent, frequency. High shear strains produce minimum (about 2.5) resonant magnifications. Since a resonance condition usually involves large isolator deformations, this low magnification value will probably apply.

The elastic modulus of BTR exhibits the typical characteristic of increasing with increasing frequency. However, BTR also increases its elastic modulus with decreasing dynamic strain. This is because of its high internal damping.

To Order Paper No. 83B . . .
. . . on which this article is based, turn to page 6.

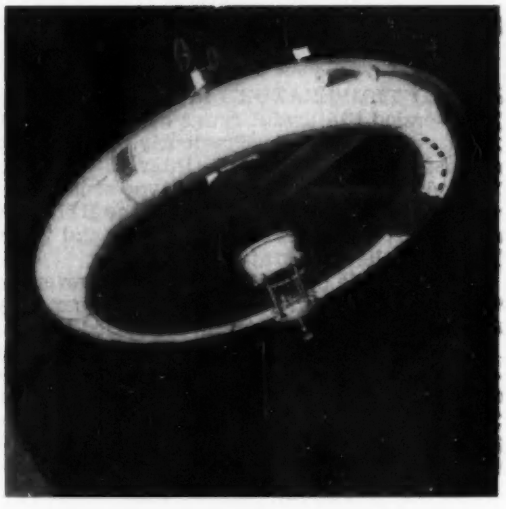
Water and ammonia evaporators show promise in

Cooling Orbital

Based on paper by

Jay S. Tupper

Hamilton Standard Division, United Aircraft Corp.



COOLING an orbital space vehicle will require the carrying aloft of a stored refrigerant. Water will probably be the first choice for the job because of its high latent heat and its ease of handling. Under the extremely low pressures available in orbit the boiling point of water is low enough to supply the temperatures needed. During exit and reentry into the atmosphere, supplemental cooling would probably be required.

In designing the cooling system for vehicle equipment or passengers, the required performance must be met with:

- Excellent reliability.
- Minimum weight.
- Simple and flexible ground handling.
- Low initial and maintenance cost.

The first requirement dictates that moving parts be eliminated whenever possible. This leads to a simple evaporator system with the cooling fluid being stored integral with or separate from the evaporator. Water satisfies the next three points.

A sample system used to demonstrate the design concepts is shown in Fig. 1. Here, two compartments are to be cooled. Each compartment must stay below 260 F. The electronic equipment needs adequate 85 F cooling air. The hydraulic fluid should be held to 200 F with 260 F max. A stable platform mechanism must be closely controlled at 52 F inlet temperature. In each case, enough cooling fluid must be used to hold prescribed exit temperatures from the equipment. Both compartments are assumed filled with nitrogen.

A secondary ammonia system is used to carry the heat load while the vehicle is in the atmosphere. In the case of the stable platform, it is used throughout the flight because the heat load is small and weight would not be saved if a second water evaporator was used. The converse is true for the hydraulic fluid. The maximum allowable temperature is high enough to boil water at sea level. Once at altitude, the hydraulic fluid can be held to the normal 200 F because of the reduced saturation pressure of the water.

choosing the transfer fluid

Nitrogen is chosen as the transfer fluid because it was already assumed for the compartment atmosphere. Using the compartment gas as a transport medium has the following advantages:

- Light and available.
- No loss of gas if a leak occurs in the cooling system.
- Simple plumbing.

If a liquid is used as the transport medium, its advantages would be:

- Low weight flow because of high specific heat.
- Less accessory power needed for pumping.
- Ease in reaching local hot spots.

Space Vehicles

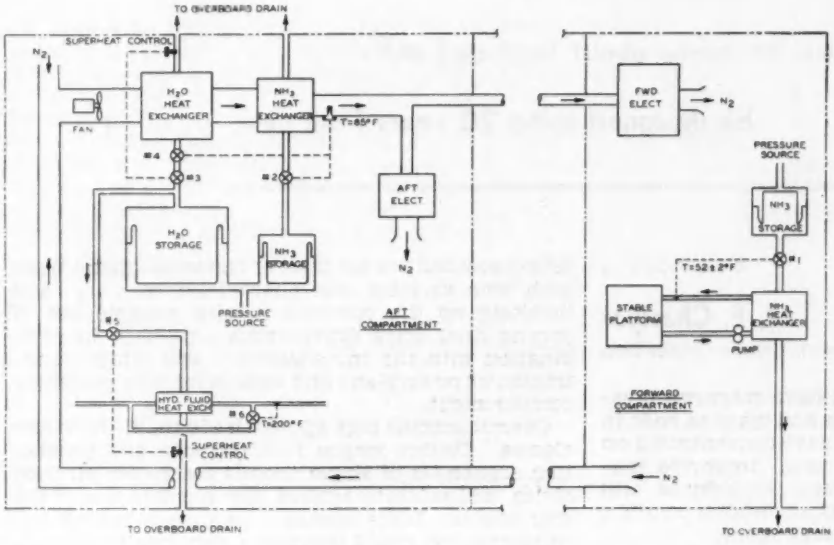


Fig. 1 — Simple evaporator system offers extreme reliability in cooling orbital vehicles. Analysis shows that a well-controlled system will give the best overall weight. This is because the refrigerant is the largest single weight item. A water-ammonia combination covers the entire flight envelope in the example presented.

In the example shown, oil is used as the transfer medium for the stable platform because of the last advantage.

operating the evaporator

The major weight of the system is in water. The evaporator must, therefore, be operated to turn all water into steam. A superheat control acts to cut down the water supply when it detects water being "carried over" with the steam.

Coolant carry-over is further reduced by packing the cold side of the evaporator with a fiber glass wick. This acts to distribute the coolant over the entire evaporator surface and to separate the liquid from the vapor. The wick is also helpful in distributing the water during the "O" *g* portion of flight.

A separate storage container for the water is preferred over an integral container-evaporator because the latter must be large to prevent spilling of the water. In the integral case, the steam vent must be placed in the middle of the evaporator and the evaporator made large enough so the water occupies less than half of the volume.

simple control used

To keep reliability high, the controls should be the direct-acting type. The sensor element in the control should develop enough force to actuate the valves. One approach might consist of liquid-filled bellows which act directly on needle- or plug-type valves to regulate the flow of fluid. This would permit sealed controls that are independent of other systems such as hydraulic or electric. They could be preset and tested without field adjustment or checkout.

To Order Paper No. 87B . . .
. . . on which this article is based, turn to page 6.

trends in

This article is "imagineering" in specific terms about how cars MAY be designed some 20 years from now.

Based on paper by

J. E. Charipar

Plymouth Division, Chrysler Corp.

THE passenger car of 1980 will have outgrown present pre-occupation with size and mass as ends in themselves. Its designers will have concentrated on better use of space and materials. Improved materials and advanced structural techniques will make even lighter body-chassis assemblies possible, with enlarged passenger and cargo space.

Basic design will have become far more effective in terms of load carried per pound of material employed. The structure of this 1980 passenger car will probably have taken several strides toward aircraft practice.

Body skin all the way round and under the car, and tail fins for directional stability at all highway speeds, are among the "probables." Aerodynamic braking may employ flaps set into such fins or into body surface . . . where they might also control airflow over the body at certain speeds for reduced drag and increased economy and performance.

Significant changes in basic automotive chassis design, mostly in the areas affected by powerplant weight and size, can be counted on. Weight and bulk will not increase though the powerplant will continue to grow somewhat in output. Use of light alloys in smaller, more compact powerplants — weighing for the largest cars under 800 lb — will permit more comfortable seating and dynamically stable forward-engine mounting on wheelbases of 125–130 in.

Various suspension media will be studied. Interesting possibilities are fluid or electromagnetic types with true variable rate characteristics. . . . And breaking up the powerplant with possible use of sprung final drive differentials — perhaps in combination with the transmission — will minimize intrusion of powerplant and final drive into passenger compartment.

Overall lengths may approach 220 in. in the larger classes. Station wagon requirements, and production economies of single chassis design for all body styles, will militate against any possible use of the rear engine. Light, compact engines, mounted forward and low, would indicate a very small tunnel, if any, in the low, roomy floor.

Consistent with developments in solar heat absorption, and in structure and sealing problems of transparent materials, increased use of glass and glass-like materials in upper-body areas can be foreseen. . . . And who knows — physics and chemistry may come up with, say, "transparent steel" for automobile roofs! Electromagnetic or electrostatically activated polarizing films on structural glass may be the answer here.

Revisions in body structure, seating design, and wheel size will contribute only minor reductions in height . . . so, we can expect the car of 1980 to have an overall height of not less than 51–53 in.

Wheel diameters will be governed by suspension characteristics, tire life, and gear and engine design for higher speeds. . . . As practical limits are reached and overall body lines become lower, perhaps the wheels will protrude into, and even "through" the body surface. Though variable rate suspension will permit lower wheel travel, increased tire sections will absorb part of this gain. . . . And the upper surface of the car may be "blistered" with

1980 car design

smoothly faired surface developments for wheel enclosure — with hood, belt line, and rear deck lowered between the wheels.

It is safe to predict that the 1980 car will have rubber-tired wheels . . . tires carrying very low inflation pressure and with larger sections than those considered large today. The tire will play an increasingly important role in vehicle suspension. By 1980 a lot more will be known about its dynamic properties and their effect on overall car stability. Tires mounted on wheels will provide brake cooling needed for high-speed operation by positioning the brakes away from the wheel — or by mounting the rim directly on the brake drum. Tires will be puncture-proof and virtually indestructible.

Unexotic fuel having rationally organized atoms will still be in use in the car of 1980. Fuel could be carried in fuel tanks or fuel cells, occupying otherwise unusable spaces in the body — such as the quarter panels or front fenders. These cells, constructed of flexible, reinforced elastomeric shells molded to the exact shape of the available space, could be literally poured into such space.

To Order Paper No. 12R . . .
. . . on which this article is based, turn to page 6.

For the 1980 Passenger Car,

the body designer might contribute:

- an expanded "space frame" — a lattice of lightweight structural members placed where loads require them and covered by stressed panels . . .
- more optimum balance between rigidity, section size, and local stress through the use of fabrication forms, such as castings, forgings . . .
- loads carried around necessary service, window, and entry openings by internal structure . . .
- more extensive use of magnesium and aluminum for lighter, roomier, more rigid body and chassis structures . . .
- larger, lighter, and easier-to-enter doors through windows fixed in curved-door panels opening into air conditioned interiors.

Missile Launching

Put Finger on Ground Support

Based on secretary's report by
P. T. Nelson Northrop Aircraft, Inc.

GROUND support equipment requirements have undergone drastic changes since World War II. Today, all possible means are used to keep critical equipment on the ground rather than in the air. This promotes reliability by paralleling systems on the ground, thereby increasing potential payload and/or range. However, failure of ground equipment has been responsible for many of the widely publicized missile launching failures, hence it is imperative that maximum consideration be given to GSE reliability in future systems.

The following SAC definition of ground handling equipment gives some idea of its magnitude:

"Any or all non-airborne implements or devices required to inspect, test, adjust, calibrate, appraise, gage, measure, repair, overhaul, assemble, disassemble, transport, safeguard, record, store, actuate, or otherwise perform a function in support of the airborne vehicle and guidance station equipment during both R & D and operational phases of the weapon system. Test GSE is that GSE used in support of the weapon system test program; operational GSE is that used in the operational weapon system."

Requirements of GSE

A detailed functional analysis must be developed to establish the GSE requirements for any system. Such an analysis would be based on all requirements, from the time of customer acceptance to operational use of the system. Facilities, too commonly considered only as brick and mortar, play an important role.

The greatest consideration of GSE should be given during the earliest stages of weapon system planning and the requirements will be dictated by the operational and maintenance concepts of the agency using the system. All the GSE in a system should be established positively, it should be practical in cost and maintenance, and should fit the level of operating personnel skill.

What Are the Chances for Standardization?

Every effort should be made to standardize GSE because the potential cost savings are tremendous, but standardization must not be carried to the extreme such that the weapon is obsolete before the standard is established. Components qualified environmentally and functionally on a previous comparable weapon system should be used on a new system having similar requirements. Moreover, all GSE elements of any one system should be standardized.

Great benefit will accrue from better coordination between designer and personnel responsible for material and standardization. And there is advantage to be had from participation by the military and from minimizing security restrictions. One serious hindrance to standardization is accelerated missile programming which makes difficult the methodical evaluation of existing hardware potential.

Effect of Air Mobility Requirements

The trend toward use of small, hard hitting forces with great fire power in place of great land armies requires all equipment to utilize fully as many different types of transporting aircraft as the size and weight of the weapons will allow. Time-consuming dismantling and reassembly must be avoided wherever possible in planning for a new design.

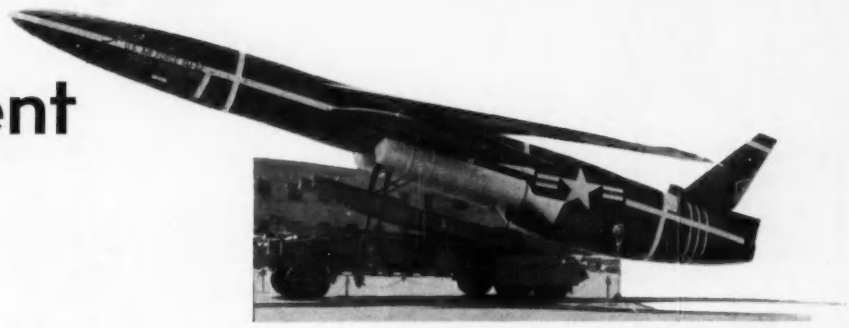
To be "air mobile" rather than "air transportable" an item of equipment should have minimum weight and be capable of transportation in a ready-to-operate condition. And that minimum weight must be gained without a disproportionate increase in overall cost. There is a balance between weight and cost in many instances. Present missile launching and handling equipment cost can be estimated roughly at $2.50 per lb, while cargo aircraft cost might run in the neighborhood of $25 per lb. Cost of optimum lightweight air-mobile equipment of the future will run somewhere between these two costs. If a large item fills an airplane without approaching the craft's lifting capacity, the need for careful weight control diminishes.

There are many ways to save weight in addition to using lightweight structure. These are:

- Multiple use of structure.
- Gas turbine powerplants for vehicles and power generation.

Failures

Equipment



- Vehicle engine power take-off for electrical, hydraulic, and mechanical energy.
- Miniaturization of electrical components.
- Circuit design to reduce long runs of bulky, armored electrical cables between items of field equipment.
- Multiple use of equipment.
- Running gear design
  a. Traction motor drive rather than mechanical drive train.
  b. Torsion bar suspension.
  c. Larger single axles rather than dual-tandem configurations.
  d. Aluminum wheels and rims.

Ordnance Tank Automotive Command has put this philosophy into effect with the M-274, T-113, T-93, and M-56 and is using advanced engineering principles in developing other lightweight vehicles. These vehicles should be considered in future systems. OTAC is investigating magnesium for wheels and is using some aluminum, although it has not yet been able to determine a cost trade-off. The Navy buys ordnance vehicles and overloads them to effect weight savings. About half the equipment above deck is now made of aluminum or its alloys.

Testing for Compatibility

A carefully developed compatibility test plan can save time and reduce cost. The approach starts prior to actual system design with determination of basic parameters, tolerance structure, types of tests, and measurement techniques. A definitive test plan is developed during subsystem design as the fruit of coordination and cross-talk between appropriate organizations. At this point, test equipment can be defined precisely and the principal parameters can be described.

The foregoing approach is intended to insure compatibility before the fact. With proper analytical effort and good design practice, no strenuous effort will be needed to get compatibility with available hardware. Nearly every item of hardware must be tested in a system hookup, even though they are high quality, standard parts which meet government specifications.

How Manufacturers Can Improve Reliability

Reliability can never reach 100%, but it can be approached. Here are suggestions to that end:

1. There are eight reasons for the lack of equipment reliability:
   a. Unrealistic demand from the field, or top echelons, for equipment beyond the state of the art — often mere "dream" ideas.
   b. Poor engineering practice.
   c. Complexity of equipment.
   d. Over-universality.
   e. Lack of foresight in procurement.
   f. Unrealistic specifications which do not require reliability.
   g. Poor production methods.
   h. Inadequately trained personnel.

2. A six-point program for improving reliability might be:
   a. Play an active role on the management council reliability team.
   b. Assume prime and definitive responsibilities.
   c. Support quality control by corrective action measures.
   d. Coordinate and cooperate.
   e. Work toward corrective action on all discrepancies rather than toward compromise with engineering to use substandard parts.
   f. Strive for personal satisfaction.

Serving on the panel which developed the information presented in this article were: panel leader: **J. E. Crawford,** Northrop Aircraft, Inc.; panel co-leader: **Ray Nelson,** Convair-Astronautics; panel secretary: **P. T. Nelson,** Northrop Aircraft, Inc.; panel members: Major **J. W. Barter,** SAC Liaison Officer, AFMTC; **J. H. Frye,** Goodyear Aircraft Corp.; **Ron Stoner,** Douglas Aircraft Co., Inc.; **W. F. Seedlock,** Lockheed Aircraft Corp.; and **A. E. VanLeuven,** North American Aviation, Inc.

To Order SP-325 . . .
. . . on which this article is based, turn to page 6.

Unknown Factor . . .

Based on paper by

Earl R. Klinge

Ford Motor Co.

A FULL analysis of truck cooling system performance is seldom completed and has rarely been reported. This is so because the nature of the cooling airflow and a measurement of its magnitude in the complete installation are unknown.

Individual pieces of data on component performance are difficult to use by themselves except for the purpose of moving up or down a small amount from a known situation. However, a system chart can be used on which data on individual component performance are superimposed. This will lead to a much better understanding of what is happening than when data fragments are viewed individually.

Error-Causing Unknown Factors

There are many unknown factors which prevent a simple cooling system analysis from representing the facts. Among them are:

1. Radiator water flow is too low or there is cavitation or aeration.
2. Estimated engine heat rejection is incorrect.
3. Fan shroud is designed poorly or is ineffective.
4. Normal fan performance is reduced by interference of the radiator core, engine pulleys, and accessories.
5. Forward vehicle velocity was not considered.
6. Radiator grille or shutters restrict the airflow.
7. Exit airflow from the engine compartment is restricted.
8. Air approach velocity is not uniform across face of radiator core.

Items 3 through 8 relate to installed airflow. A reasonable method for dealing with these variables is to use an air side system chart.

Representation of many things happening to the air side of the cooling system can be made on a head versus flow chart as shown in Fig. 1. It also permits some guessing on probable airflow by static head measurement. Presumably the system flow is at point "A." If, however, a higher total fan head is measured say of 3.5 in. H_2O, it can be deduced that the system flow is near "B" due to increased system resistance. If a lower total fan head is found, it is likely to be the result of reduced fan performance as "C", or combined lower fan performance and higher system resistance as at "D." This applies to shrouded fan and radiator installations where static heads exist and may be measurable.

Preparation of a Useful Chart

Items 3 through 5 on the list of unknown factors relate to the question of "cooling air head" production. The cooling air head producing factors can be shown as in Fig. 2. Curve (A) is fan performance in a tunnel. Curve (B) is installed fan performance produced by interference in front of and behind the fan (one inch was assumed between fan and core and 4 in. between fan and engine pulley). Curve (C) is fan performance with a loose fitting shroud and 1 in. tip clearance. Having determined static head versus vehicle velocity, this head is applied as additive to the fan head, with the results shown in curve (D). Curve (D) then represents total cooling air head available with fan as installed with loose shroud and the vehicle moving at 15 mph.

Items 6 and 7 of the unknown factors relate to "system resistance" to the cooling airflow. They can be shown as in Fig. 3. Curve (A) is the radiator core resistance. Curve (B) shows an entrance grille resistance added. Curve (C) shows engine compartment exit resistance added. Curve (C) is thus the total system resistance curve.

By superimposing the chart of total cooling air head available upon the chart of total system resistance (Fig. 4), a very useful chart results, to show probable system airflows for a variety of conditions. Orders of magnitude and sense or direction of effect can be seen, even if exact values are doubted.

To be of maximum value, the information on components in the system should be collected in a manner to permit use of a system chart. For example, a single point of data showing the pressure drop at a given airflow through a complete vehicle (with fan not running) will permit a reasonable system chart to be drawn. More information is needed on fan performance versus distance from obstructions to permit more intelligent choice of the space to be demanded by the fan. The value of fan shroud design improvement has been badly neglected and the merits of specific designs should be evaluated on a system chart.

To Order Paper No. 99C . . .
. . . on which this article is based, turn to page 6.

in truck cooling system performance analysis is installed airflow. System chart will help understanding and point paths to improvement.

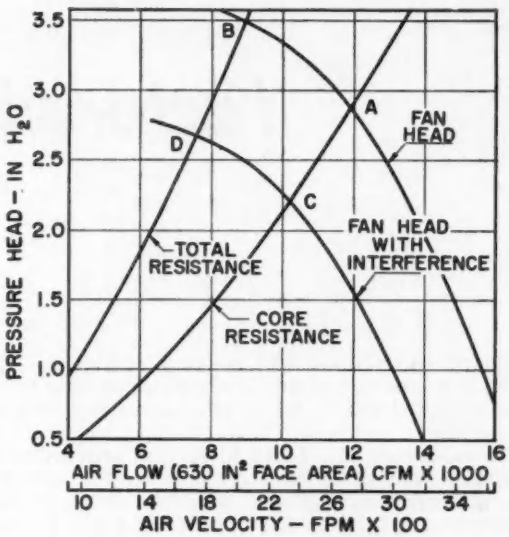


Fig. 1 — Typical system chart of head versus flow reveals much that happens to the air side of a truck cooling system.

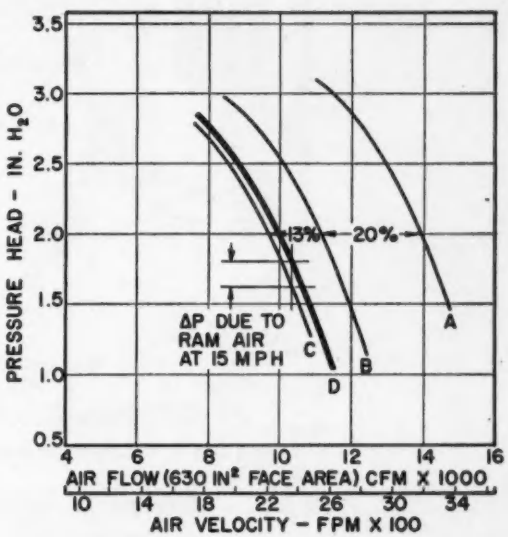


Fig. 2 — Total cooling air head available is shown by curve D. A is fan performance in tunnel; B is installed fan performance produced by interference with fan; C is fan performance with loose fitting shroud and 1 in. tip clearance.

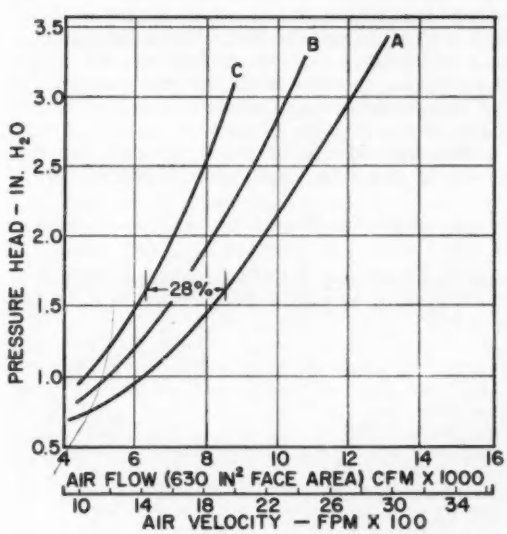


Fig. 3 — Here is the curve (C) of total system resistance. A is radiator core resistance; B adds entrance grille resistance; C adds engine compartment exit resistance.

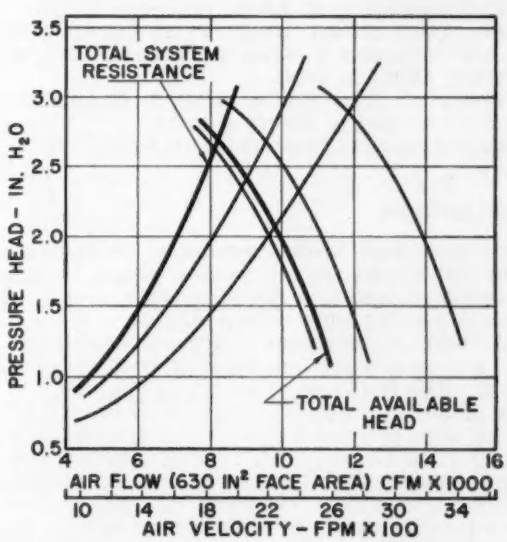


Fig. 4 — Combining the data on Figs. 2 and 3 gives a complete system chart showing the probable system airflows for a variety of conditions.

man in

factors in

Based on a paper by

Edwin G. Aiken,

Convair, Division of General Dynamics Corp.

Eugene B. Konecci,

Douglas Aircraft Co., Inc.

BEFORE man can project himself into space, a number of basic problems must be solved:

1. Maintenance of an adequate oxygen supply.
2. Protection against changes in the force of gravity — the increased *g* stress of take-off and the weightless phase in orbit.
3. Protection from the extremes in thermal environment, especially during re-entry.
4. Maintenance of pressure within the cabin.

oxygen pressure

For a short flight to the moon on which space and weight restrictions are not serious, oxygen balance may be maintained by a liquid oxygen system or by chemicals which absorb carbon dioxide.

The liquid oxygen system is lightweight and compact. However, it may not function properly under the weightless condition of an orbiting vehicle.

One promising chemical is lithium hydroxide, 1 lb of which absorbs about 1 lb of carbon dioxide, forming lithium carbonate. This method is heavy, however. If weight is to be conserved, the regeneration of lithium hydroxide is necessary. There is at present no feasible means of reconverting lithium hydroxide from the carbonate.

A round trip to Mars will take about 1000 days. On such longer journeys, the storage space and weight restrictions will be very stringent. Thus, other means of oxygen supply must be found: pressurizing the cabin, use of photosynthesis, and photolysis.

Pressurizing the cabin to several atmospheres of oxygen eliminates the storage problem. Investigations have indicated that man can tolerate oxygen pressure as high as 425 mm of Hg for a prolonged period (oxygen pressure at sea level is 159 mm of Hg). Above this, hyperoxia begins.

The suggested use of green algae as a photosynthetic gas exchanger in a space cabin needs a great deal more study before it can be accepted.

Photolysis is the decomposition of respiratory carbon dioxide with ultraviolet light and a catalyst. A means of controlling carbon dioxide in the cabin, the method also returns some of the oxygen for reuse by the passengers. The abundance of ultraviolet light in space is an attractive feature of this idea. Other byproducts of the reactions are not known — it is possible that carbon monoxide or

Table 1 — Estimated Daily Energy Expenditure of Man in Sealed Space Cabin

	Kilocalories per hr	Kilocalories per day
Sleep, 8 Hr	65	500
Light Work, 8 Hr	150	1200
Sitting, at Rest, 5 Hr	100	500
Lying, at Rest, 1 Hr	80	80
Light Exercise, 1 Hr	200	200
Heavy Exercise or Work, 1 Hr	500	500
Total		3000

space survival

methane are also produced. The results of first tests are shown in Fig. 1. Work is continuing at Douglas on the idea.

The magnitude of the problem is clear from estimates of the daily energy expenditure of a man in space (Table 1). If the average space man expends 3000 kilocalories per day, burning food at an average respiratory quotient (ratio of CO_2 produced to O_2 consumed) of 0.82, he will consume about 2 lb of oxygen per day at a rate of approximately 1.0 cu ft per hr. In this process, he will produce approximately 2.5 lb of carbon dioxide per day.

acceleration stress

A means of protecting the space man during the severe *g* stress of take-off is shown in Fig. 2. The seat provides body support and immobility through contouring. The helmet is restrained by a bivalve clamp which can be snapped away to free the head during the weightless phase in orbit. The seat must have moderately compressible padding with a slow return rate, to accommodate both the high *g* stress and the sudden loss of gravity as the vehicle goes into orbit.

Another promising approach to the problem is the "immersion suit." The idea is that a man's tolerance of *g* forces is increased if he is encased in a nonelastic suit filled with water. (See Fig. 3.) Theoretically, since the specific gravities of water and blood are quite close, a man suspended in water would experience no major blood displacement even under very severe accelerations. One encouraging

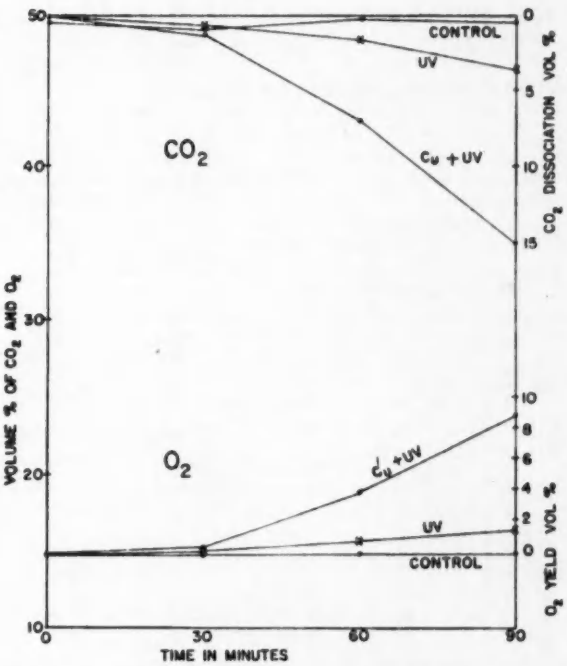


Fig. 1 — Process of photolysis: absorption of carbon dioxide in sealed cabin by ultraviolet light and copper catalyst. Test was in three parts: (1) control of copper alone, (2) ultraviolet radiation alone, and (3) copper catalyst and ultraviolet radiation.

man in space

. . . continued

point about this idea is that an inch of water around a man weighs only about 100 lb. The concept is currently being investigated at WADC.

weightlessness

At present, the best approach to the problem of weightlessness seems to be simulation of the lost force of gravity. One means of attaining this is the use of constant tension springs to add an artificial pull on the limbs (Fig. 4).

It is likely that adaptation and experience will overcome some of this problem, as it has in parabolic jet flights. But the effect of the loss of gravity on the mechanisms of the inner ear is likely to be very serious, and is a question that has not yet been solved.

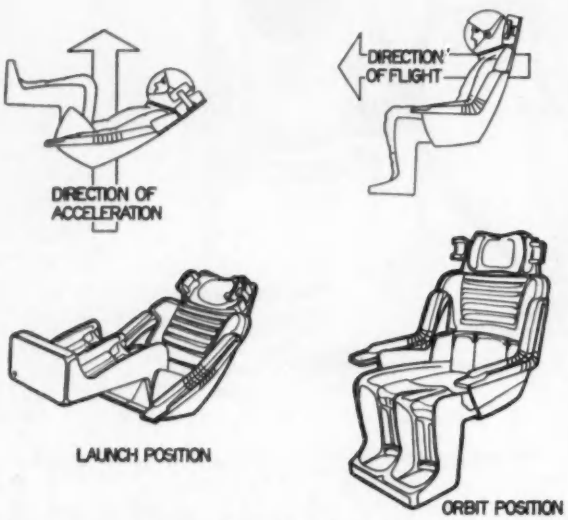


Fig. 2 — Contoured seat in launch and orbit position.

high thermal environment

Temperature control in an orbiting space vehicle is not expected to be a problem. Systems which serve to balance radiant loads into and away from the vehicle have proved effective in the first satellites. However, the pilot must be protected from the high temperatures during the re-entry phase of flight, a period of about a half-hour.

Because of its advantages in providing restraint during weightlessness, a full-pressure ventilation garment will probably be used in the first short flights. Work by the Air Force and Navy points to the development of space suits that may be worn as long as a week before removal.

Even if the pilot is encased in a protection suit, the allowable extremes in cabin temperature are limited to the pilot's ability to withstand a failure in the suit's cooling supply. Thus, a method of cooling the space cabin during re-entry must be found.

decompression

All of these precautions are for naught, however, if the pressure in the cabin is lost. This can happen for a variety of reasons: leaky seals, structural leaks, collision wnth meteoroids or other cosmic debris, and mechanical failure. A hermetically sealed cabin is mandatory.

Unfortunately, many of the questions about space flight can be answered only tentatively from results of laboratory tests. Final answers must wait until the first manned flight into space.

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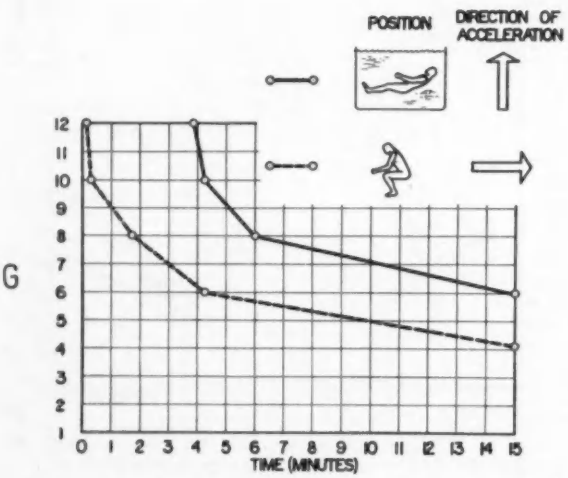


Fig. 3 — Comparison of *g* tolerance under immersion and nonimmersion conditions.

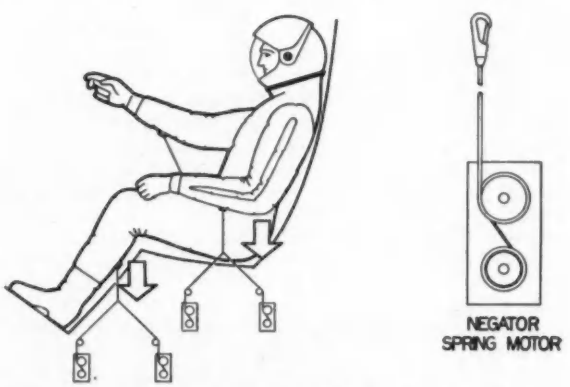


Fig. 4 — Gravitational simulation by a constant pull system, to aid pilot's orientation during weightless phase of orbit.

Aluminum Drums Improve Brake Performance

Based on paper by

R. L. Atkin and F. J. Weber

Kelsey-Hayes Co.

EXPERIMENTS carried on at Kelsey-Hayes prove definite advantages to accrue from the use of aluminum in brake drums. The resultant lower brake operating temperatures reduce or eliminate fading, extend lining life, give greater stability and freedom from erratic action, while noise is reduced even when braking action is severe. These advantages are particularly noticeable with an integral construction of hub and drum.

Three main categories of aluminum drums were evaluated:

1. Mechanically locked liners.
2. Metallurgically bonded liners.
3. Others, such as surface-treated and hypereutectic silicon aluminum with silicon content from 18 to 25%.

Three types of mechanically locked liners were tested, as shown in Fig. 1. The flared rib type had a radial rib with lateral cast-in holes. When aluminum is cast around the liner, locking is achieved by filling the holes in the rib of the iron liner with molten aluminum. The pipe, or straight, liner type is locked by using a rough-cast lattice-like surface on the outside diameter of the liner. In the case of the shrink-fit liner, the inside diameter of the aluminum drum casting and the outside diameter of the cast-iron liner are machined to controlled dimensions. With the aluminum shell heated and the liner cooled, the liner is inserted in the shell. On return to ambient temperature, a predetermined diametral interference exists between the two diameters.

metallurgically bonded liners

Of the two metallurgically bonded types tested, one also had a mechanical lock. In both these types, the cast-iron liner was dipped in a molten aluminum bath before the outside shell of aluminum was cast. These types are shown in Fig. 2.

In the third category of surface-treated drums, several types were tested. Brake linings were run against bare, hard-anodized, and chrome-plated aluminum braking surfaces. In another instance the braking surface was formed by spraying steel onto aluminum. Where tests were made with hypereutectic silicon aluminum alloy drums, no cast-iron liner was used, the brake lining being run directly against the alloy.

To compare the heat dissipating characteristics of the mechanical lock and the metallurgical bond, dynamometer tests were run with two drums of identical construction. One drum had only the mechanical lock feature, the other had both mechanical lock and metallurgical bond. Under the same procedure and with the same temperatures 0.090 in. from the braking surface, the temperature gradient across the drum was rather constant with the metallurgical bond, but a heat dam occurred at the iron-aluminum junction of the mechanical-bonded type.

Road tests of similar drums substantiated the superiority of the metallurgically bonded liner re-

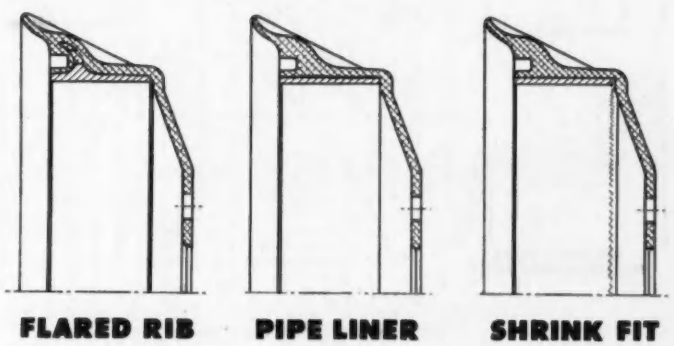


Fig. 1 — Of these mechanically locked liners, tested to determine how best to use aluminum in brake drums, the shrink-fit type proved the best performer.

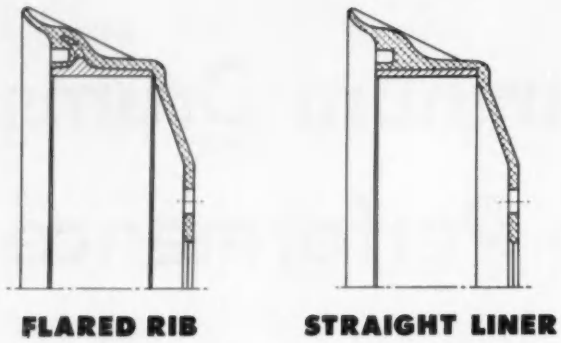


Fig. 2 — Metallurgical bonding proves better than mechanical locking and the straight liner type has the best heat-dissipating characteristics.

Aluminum Drums Improve Brake Performance

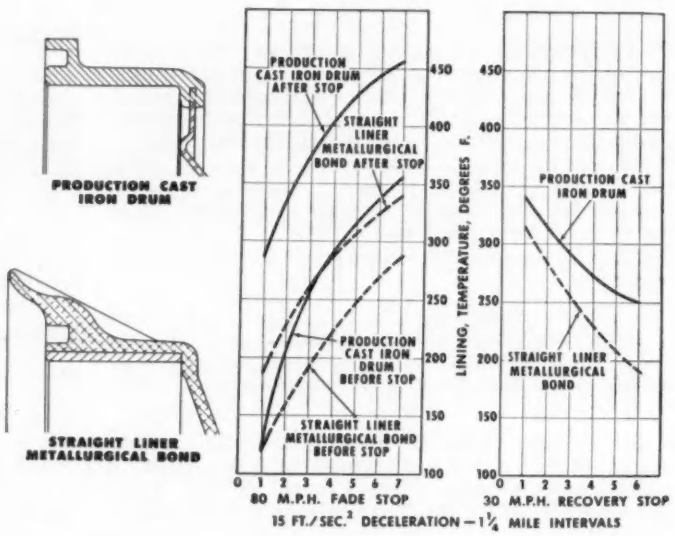
... continued

vealed by the dynamometer test, but both types showed a considerable amount of brake roughness.

operating temperatures fall

Because the flared rib type showed brake roughness, and to conserve weight, the simpler straight cast-iron liner was substituted. The merits of this type of drum are shown in Fig. 3, where its performance is compared with that of standard production drums. Operating temperatures ran lower, the rise in brake lining temperature during stops is very slight, and recovery of the aluminum drums is more rapid.

Fig. 3 — Aluminum drums with straight cast-iron liners metallurgically bonded have lower brake operating temperatures than standard production drums. Brake lining temperatures rise only slightly during stops, and recovery is more rapid.


PRODUCTION CAST IRON DRUM
STRAIGHT LINER METALLURGICAL BOND
PRODUCTION CAST IRON DRUM AFTER STOP
STRAIGHT LINER METALLURGICAL BOND AFTER STOP
PRODUCTION CAST IRON DRUM BEFORE STOP
STRAIGHT LINER METALLURGICAL BOND BEFORE STOP
LINING TEMPERATURE, DEGREES F.
80 M.P.H. FADE STOP
30 M.P.H. RECOVERY STOP
15 FT./SEC.² DECELERATION — 1¼ MILE INTERVALS

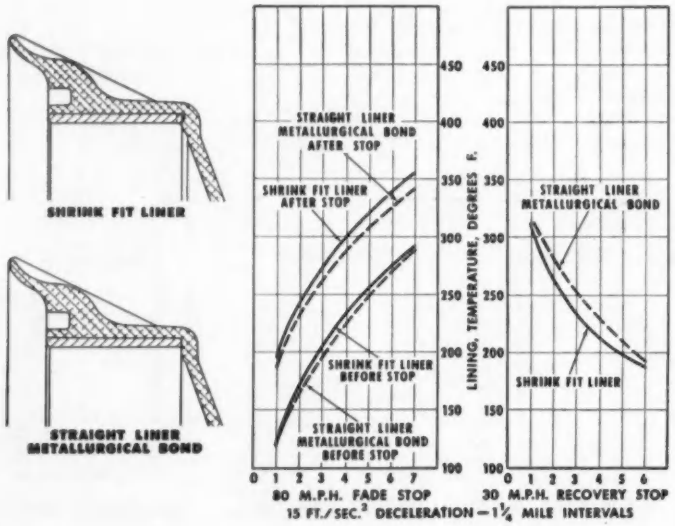

SHRINK FIT LINER
STRAIGHT LINER METALLURGICAL BOND
STRAIGHT LINER METALLURGICAL BOND AFTER STOP
SHRINK FIT LINER AFTER STOP
SHRINK FIT LINER BEFORE STOP
STRAIGHT LINER METALLURGICAL BOND BEFORE STOP
LINING TEMPERATURE, DEGREES F.
80 M.P.H. FADE STOP
30 M.P.H. RECOVERY STOP
15 FT./SEC.² DECELERATION — 1¼ MILE INTERVALS

Fig. 4 — Aluminum drums with shrink-fit liners, mechanically locked, rank close in performance to the type with metallurgically bonded, straight liners.

Success with the straight metallurgically bonded liner led to experiments with the shrink-fit mechanically bonded straight liner, and it, too, showed good heat-transfer characteristics. Road tests of the straight metallurgical bond versus shrink fit, showed the latter to rank well in favorable characteristics. This is shown in Fig. 4.

Dynamometer tests run on plain aluminum, anodized aluminum, and chrome-plated aluminum braking surfaces were unsatisfactory with standard linings because of the scoring and wearing of the drum braking surfaces. Tests with aluminum alloys of varying silicon content proved more encouraging. Machining, braking surface conditions, and brake effectiveness appeared to be good. Lining life at the outset of the tests was only 15% that of the same lining against production drums, but gains since made with the alloys have raised lining life to 80% of that with production drums.

results with sprayed steel liners

From the standpoint of endurance, sprayed steel liners are promising. But indications are that brake lining changes will be needed for more effectiveness. The hardness of the sprayed steel liner results in a lower coefficient of friction between liner and lining. Moreover, the hardness creates a machining problem.

capitalizing on aluminum

Theoretically, obtaining more aluminum heat radiating area and more airflow across this area should improve brake performance. With this in mind, an assembly was designed which had not only a heat radiating surface on the outer periphery of the drum ring, but also an extension of it into the area normally occupied by the drum back and the disc or spider of the standard passenger-car wheel. This design (shown in Fig. 5) provided the ultimate in exposure to the air stream and an open air path completely across the drum. The large mass of aluminum also served as a reservoir for high-heat-input brake stops.

This integral design employs metallurgically bonded liners, and since the drum back in the integral hub and drum assembly serves as a structural portion of the wheel, high purity A356 aluminum, having high elongation, was specified.

Prototypes were tested on rotating fatigue and rim test machines with excellent results except for loosening of the bearing cups in the aluminum casting. This was corrected when strain gage checks showed need for additional thickness of aluminum in the hub barrel area to keep combined assembly and load stresses below the yield strength of the section.

Comparisons have been made between the integral hub and drum assembly and production cast-iron drums. Their relative performance under a few of the conditions evaluated is shown in Fig. 6.

To determine to what extent the use of closed or vented wheel covers would impair performance of the integral design, a series of tests was run with wheel covers installed. Temperatures ran somewhat higher and recovery was slower, but performance was still satisfactory. Indications are that a combination of properly vented covers and integral hub and drum design may afford an acceptable compromise, offering adequate brake performance and wheel cover style flexibility.

To Order Paper No. 14R . . .
. . . on which this article is based, turn to page 6.

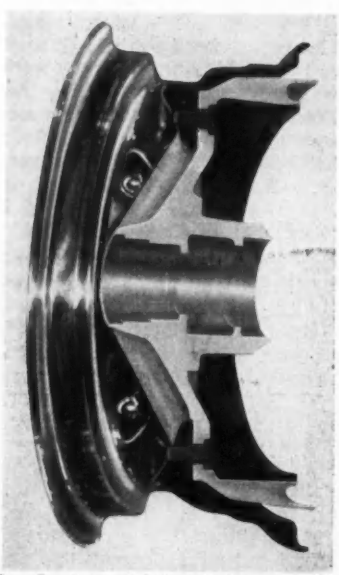


Fig. 5 — Integral hub and drum assembly design gives large heat radiating area of aluminum and open path for air stream across entire drum. Drum back is structural portion of the wheel.

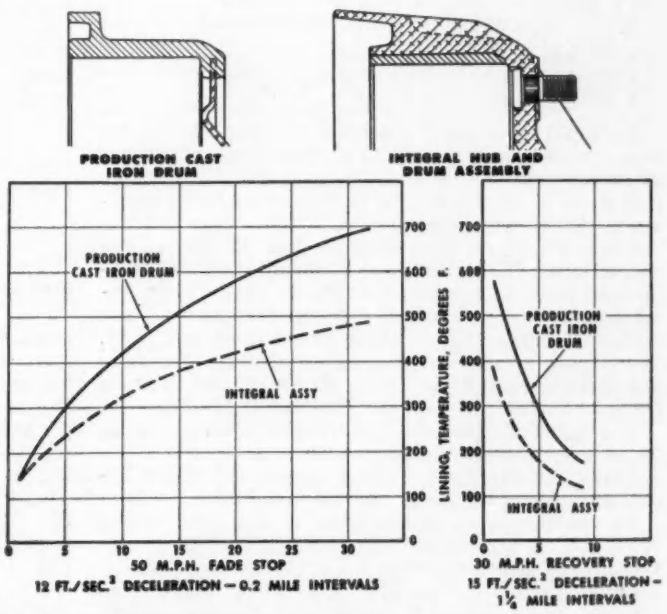


Fig. 6 — Aluminum brake drums of the integral hub and drum type have lower operating temperatures than production cast-iron drums, hence lining life is longer and there is less tendency to fade.

Supersonic Inlet Designs

Based on paper by

Fred A. Wilcox

Lewis Flight Propulsion Laboratory, NACA

THE TREND in Mach 2+ engine inlet designs is toward separately controlled shock-wave geometry and bypass air. These two loop control systems will team up with the turbojet engine control loop to give maximum performance. However, three basic problems have to be solved early in the aircraft design to make variable inlet control successful. They are: selection of the inlet geometry, the method of sensing the airflow conditions, and the design of stable high-response controls.

How to Make Shock Waves Work

The purpose of engine inlet ductwork is to convert the high-speed approaching air into high-pressure low-speed air as efficiently as possible. This is usually done by first having a series of oblique shocks, which are quite efficient, and then ending with a normal shock, which is relatively inefficient. The normal shock inefficiency is overcome if the shock can be positioned so the air approaching it has a speed just over the speed of sound.

Three ways of forming the shock waves are:

- All external shocks.
- Shocks inside and outside the ductwork.
- All internal shocks.

A simple example of all-external shock compression is shown in Fig. 1. The oblique shock is formed by making the air turn past a nose spike. The normal shock is then taken at the lip of the inlet ductwork. This arrangement is most efficient when the oblique shock just intersects the lip. If the oblique shock lands inside the lip, some air will be compressed only by the normal shock. The other extreme is to do the work of compressing air with the oblique shock and then let it miss the engine inlet. This shows up as increased external drag. To keep the optimum condition, the center spike has to move forward as the speed of the airplane increases.

The external-internal compression inlet shown in Fig. 2 uses two more oblique shocks to increase the efficiency of the inlet. These shocks are taken inside the ductwork, as is the normal shock.

The performance of this inlet is also sensitive to the position of the oblique shock generating surfaces. For example, when the spike is retracted excessive contraction occurs in the throat and causes the inlet to "unstart," as shown by the shock pattern in the left-hand sketch of Fig. 2. When the normal shock is expelled the pressure recovery drops abruptly to the low value indicated and some oscillation of the expelled shock would result. Extension of the spike beyond the design position would result in decreased pressure recovery because of the decreased contraction. The inlet shown is designed so that as the Mach number decreases from the design value the spike is moved forward to keep the first reflected oblique shock at the high point on the centerbody (this simultaneously decreases the amount of contraction). The oblique shock forming at the spike tip then falls ahead of the cowl lip. One way of controlling the spike position is to sense the first reflected shock location near the centerbody and extend the spike to keep the shock at the high point on the spike.

A third inlet type has all of the deceleration or compression occurring inside the cowling and is called the all-internal-compression inlet. This inlet (shown in Fig. 3) utilizes a very low angle spike and cowl and has many internal oblique shocks reflecting from both the spike and cowl, followed by a normal shock located near the throat. At design conditions the spike tip is near the plane of the cowl lip, and the throat is located some distance downstream. Retracting the spike beyond the design point causes the inlet to unstart, due to overcontraction, and the pressure recovery decreases abruptly to the normal shock recovery value. Translating the centerbody forward of the design point results in a dropoff in recovery because of the reduction in internal contraction. As with the external-internal compression inlet the amount of internal contraction (or centerbody position) must vary with Mach number to avoid unstarting.

Bypass Control of Shocks

The success of a high-speed inlet depends on the airflow and back pressure as well as the geometry of the ductwork. The engine dictates the airflow requirements and the inlet must match. Since the inlet cannot accommodate all flight conditions, a bypass or air bleed is used to match the ductwork to the engine. Otherwise, the inlet might pass more air than the engine could use. This air would build up the pressure behind the inlet and result in "blowing-out" the normal shock wave. This blow-out or unstarting causes the air to be compressed through one large, inefficient shock wave. The left-hand part of the graph in Fig. 3 shows the pressure loss that follows a shock blow-out. In general, the position of the normal shock acts as an indicator for the bypass device. The normal shock should be held at the minimum cross-section part of the duct for best efficiency.

- use shock sensing pressures
- separate shock wave and bypass controls

Sensing the Inlet Flow

The most direct way of controlling the inlet geometry and bypass is the detection of the oblique or normal shocks. Other methods, such as programming the controls against free-stream Mach number, are possible but require integration of considerable additional information.

Pressure measuring devices work best when an abrupt change of pressure is available for a control function.

In the case of the simple external shock pattern (Fig. 1), a pressure sensing probe can be located at the lip of the cowl. This pressure is compared with a pressure measured at the tip of the spike. When the spike is retracted too far the cowl probe and spike probe sense the same pressure — the pressure behind a single normal shock. As the spike moves forward the cowl probe senses the pressure behind an oblique and normal shock — which is higher than the spike probe pressure. Control of spike motion can be based on a pressure between these two extremes, as shown in Fig. 4.

An alternate way of controlling the spike position is illustrated in Fig. 5, and is based on the variation of the throat Mach number with spike translation. For example, as the spike is retracted closer to the design position, the throat Mach number decreases toward the value at which the inlet will unstart and more importantly this minimum Mach number is nearly constant for various flight Mach numbers. The Mach number at the throat can be measured by taking a ratio between pressures measured by a stream pitot tube and a wall static, or a pitot tube and a backward facing total probe. A control setting would be selected at a ratio corresponding to a Mach number close to the minimum permissible. For a throat Mach number above this value, the spike would be retracted and below extended. It is not possible to obtain peak recovery with this system as peak recovery occurs at the point where the inlet unstarts.

The principle of normal shock position sensing for bypass control is shown in Fig. 6. The sketch on the left shows a two-dimensional-external-internal compression inlet and the lower part of the figure shows the pressure that would be indicated by a wall static orifice for various positions of the normal shock along the length of the inlet. The normal shock shown here is not distinct but is in a train or system of shocks. If the entire shock train is downstream of the sensing orifice, the pressure at the orifice is low. As the shock train moves forward of the orifice the pressure rises. This pressure rise can be used to operate a control by comparing it to a

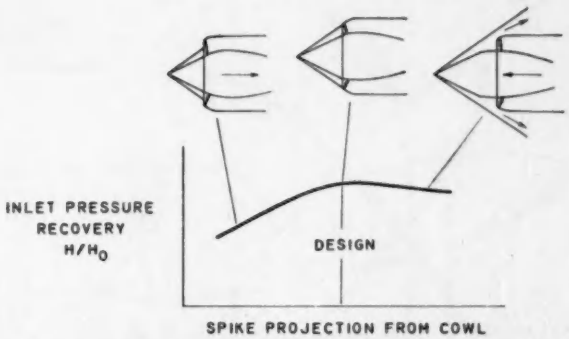


Fig. 1 — All-external-compression inlet controls efficiency by moving the spike so oblique shock intersects the cowl lip. A variation of this type of inlet is to put a ramp on the spike so a second oblique shock will be generated. This improves efficiency but makes it difficult to have both oblique shocks intersect the cowl lip, except at design Mach number.

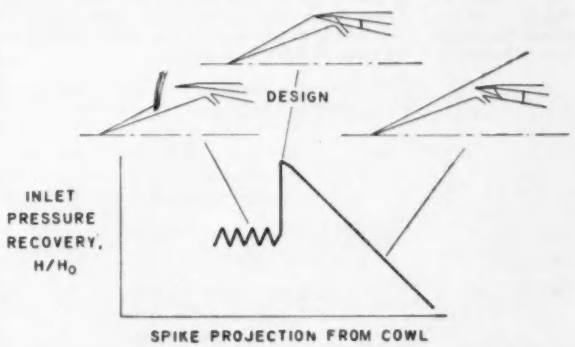


Fig. 2 — External-internal compression inlet permits several high-efficiency oblique shocks. In this design overretraction of the spike results in a constricted passage and "blow-out" of the normal shock. When this happens unstable pressures can be expected.

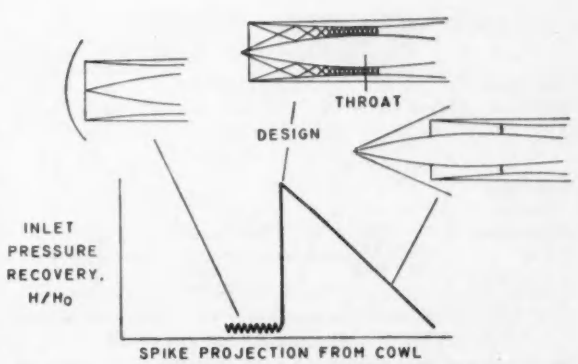


Fig. 3 — All-internal-compression inlet produces a high-pressure recovery at design conditions by multiple oblique reflected shocks. However, efficiency drops rapidly when the spike is over or under extended. This design has the poorest recovery when the shock is blown out because no part of the oncoming air experiences an oblique shock.

Supersonic Inlet Designs

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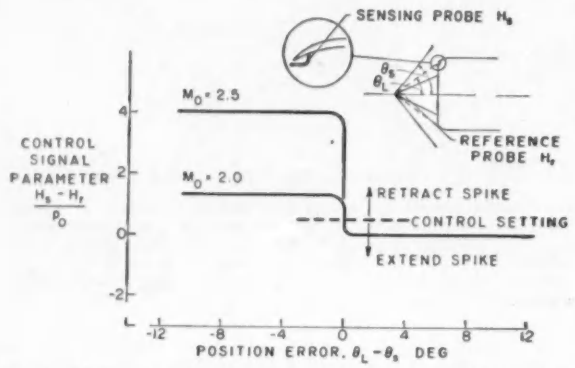

Fig. 4 — Spike position control can be achieved by a total head tube at the lip of the cowl. The control setting pressure is just above the point where the oblique shock intersects the inside of the cowl. This gives control action for a full range of Mach numbers.

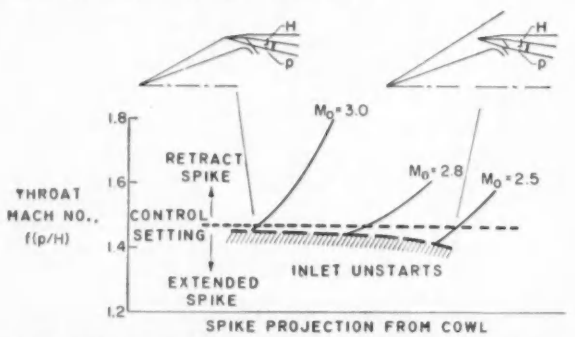

Fig. 5 — A second method of controlling spike projection in an internal-external compression inlet is by detecting the throat Mach number. Optimum operation is when the normal shock is just ready to blow out. This type of control has the advantage of being relatively insensitive to changes in free stream Mach number.

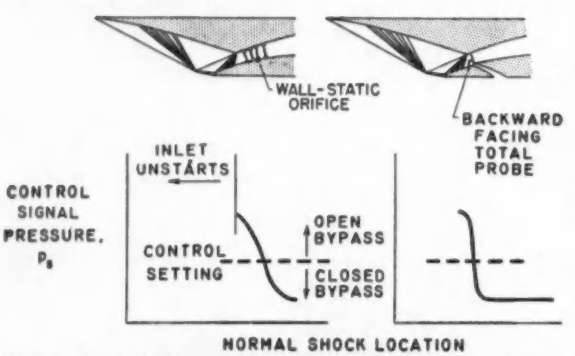

Fig. 6 — Normal shock position is a direct indication of the engine airflow requirements. This fact is used to control spillage or bypass devices. A steeper control pressure curve is obtained when the boundary layer is bled off and a total pressure tube, facing backwards, is used. Bleeding off the boundary layer converts a diffused normal shock to a thin one.

control setting and causing the bypass to open if the pressure is higher than the set point and to close if lower. With the shock train spread over a region as shown the control signal pressure curve has a shallow slope which would make precise control difficult. Removal of the boundary layer on the cowl, as shown in the right-hand part of Fig. 6, is effective in reducing the thickness of the shock train and also significantly improves the inlet pressure recovery. The position of the normal shock system can also be determined by use of a backward facing total probe, which will generaly provide a steeper control signal slope.

Air spillage variation can also be provided by means of translating spike or variable ramp oblique shock generating surfaces controlled by normal shock position sensing or Mach number measured at the throat of inlets having internal contraction. It is also possible to measure diffuser discharge Mach number ahead of the bypass to provide spillage control.

Control Loop Selection

There are two categories of inlet variable that will require controls. There are:

1. Those parts of the inlet which generate oblique shocks.
2. Those parts which control spillage of excess air not required by the engine.

For some inlets these functions can be combined but as the design Mach number increases, the trend will be to control them separately.

The gains of the various elements of the control loop are rarely constant over their full range of operation. An inch of travel of the bypass door may result in a greater change in discharge area at one end of its travel than at the other. This would mean that the designer would have to stabilize the loop for the high gain position of the bypass and then suffer slower control action when the bypass operates in the low gain position. An alternate solution would be to schedule a variation in loop gain with bypass position. The gain or slope of the normal shock signal curve varies:

- According to the amount of shock boundary layer interaction at the sensing point.
- As flight Mach number changes and the normal shock becomes stronger or weaker.

Thus, the designer will be forced to stabilize the control loop at the high gain condition or put in a variation in the gain setting. The servo actuator is also subject to nonlinearities as well as hysteresis and null shift. Since boundary layer removal in the region of the normal shock can affect not only the gain of the shock sensor but the potential performance of the inlet, some form of bleed control for the boundary layer air is usually necessary.

The use of on-off systems with a dead band can result in a more simple control, provided the response requirements are not too high. The control designer can improve the response of the control by use of lag compensators in which a lead network is used to cancel some of the lag in the system. To use this, however, careful measurements of the existing system lag are required.

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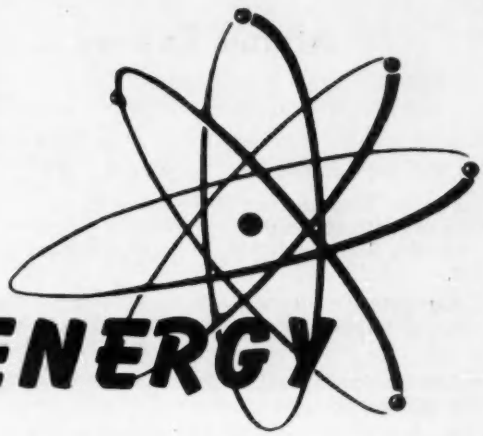

ATOMIC ENERGY

Suggested by the

SAE Nuclear Energy Advisory Committee

PERIODICALLY, the SAE Nuclear Energy Advisory Committee makes available to *SAE Journal* readers a list of recently published books, articles, reviews, and new periodicals covering all of the major phases of development in the atomic energy field.

This list supplements the following lists previously published in *SAE Journal:* October 1956, pp. 45–47; November 1957, pp. 82–83.

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seaplanes need open-sea

WE need a big, sturdy sea-basing aircraft that can operate safely from the open sea. We need it for national defense, for immediate and future rescue, and possibly for use with nuclear propulsion powerplants.

It will cost money, and it will require both the best possible application of our present knowledge and an extension of our knowledge of sea-surface conditions and aircraft design. It will be worth the cost and the effort.

make it a seaplane

The most important qualities needed in this seaplane for open-sea operation are:

1. Ability to touch-down at low speed and stop quickly; controllability below stall speed.
2. Ability to take-off quickly and with a very short take-off run.
3. Ruggedness and stability to drift safely or maneuver slowly on a rough sea and in high winds. This phase of the problem should include consideration of dampers, flexibility, and shock-alleviating devices.
4. Access hatches and weight-handling gear so that boats or rafts can be brought to the seaplane and stores or personnel loaded or off-loaded quickly and safely.
5. Ability to cover great distances. We must have range, even at the expense of speed. But neither should be allowed to limit the open sea performance of this seaplane. There is no point in going anywhere at any speed if one can't do the job on arrival.
6. Resistance to corrosion — and to failure. Build it to *operate*, not to "fail safe". Above all, don't "booby trap" it.

The landing and take-off problems are fundamentally impact-loading problems. The conventional seaplane landing approach involves touch-down at from 60 to 140 knots, and a decelerating run across chop and swell. The big seaplane may smash her way through some low chop but must go up and over great waves and swells. The speed with which the seaplane hits the water and the effectiveness of means supplied for rapid deceleration are most important. No seaplane design engineer can afford to forget the simple formula $E = \frac{1}{2}MV^2$.

(Every recent seaplane seems to land faster and run longer and faster for take-off than its predecessor.)

Positive flight control below stall speed is an obvious necessity when you remember that the planing seaplane will often be thrown into the air below flying speed.

A VTOL seaplane would, of course, solve the landing and take-off problem immediately. In addition, such an aircraft could air-taxi to its berth or cradle and would permit wider latitude in design of a good sea-keeping hull.

The helicopter with ability to cruise 2000 miles and carry 50 passengers the last 1000 miles would nearly solve the problem. This machine should also be able to stop and start her rotors without damage while rolling and pitching wildly.

STOL principles offer hope

Probably the most promising early answer to the sea-basing aircraft problem lies with thorough application of all possible advantages of the STOL machine. Conceive a sturdy 50- or 100-ton seaplane touching down under firm control at less than 40 knots on a hydrofoil and equipped with positive reverse thrust and water brakes that will stop her at 100 yds.

I would undertake to land such a seaplane in a 20-ft sea tomorrow.

To design open-sea capability into this sea-based aircraft, we need to apply all our knowledge of sea waves. We can presume:

- The sea wave is not a wall of water rushing across the sea surface, but a wave of energy. Example: throwing a wave through a rug or a rope.
- The water particles under a wave train move in vertical orbits, roughly approximately the curve of the wave, advancing with the wave at the top and regressing in the trough. Smaller and smaller orbits are found with increasing depth. At a depth of one-half the wave length the orbits are only 1/23 the size of those at the surface. The water particle velocities rarely exceed 3 or 4 knots. The stability of the water at depth suggests the feasibility of using motion dampers on long lines.
- The slope of a single wave will not commonly exceed a height to length ratio of 1/13; will never exceed a ratio of 1/7 because at this point a water

capability

wave becomes unstable and breaks. Ratios of from 1/25 to 1/100 are common. The slope is not constant.

- Wave trains of considerable differences in length and velocity must be expected from the direction of a storm area.
- Most of the energy in a spectrum of waves will be found in a very small part of the spectrum. This dominant wavelength area will be directly related to the strength of the wind that generated all these waves.
- Trains of long waves will travel faster than trains of short waves and pass through and under them.
- At moments when one wave passing through another during overtaking is in coincidence with the wave overtaken, the momentary resultant wave will be almost equal to the sum of the heights of the waves in the coincidence. When crests of one train fill the troughs of the other, the sea almost smooths for the moment.
- Wave trains may be expected to appear and continue to pass through each other with small decay from directions up to 90 deg apart. But wave trains opposing decay rapidly until one dominates or both disappear.
- The energy in a wave is proportional to the square of the amplitude of that wave.
- The total energy in a newly developed sea is proportional only to 3 factors; (a) The force of the wind that raised it, (b) the duration of the wind that raised it, and (c) the effective distance over which that wind blew. Geography or temperature do not affect it significantly.
- A train of waves will advance with a speed equal to ½ of the velocity of the waves of that train. If we can forecast the rough we can find the smooth.
- Wave velocity may be determined by timing the period from an aircraft and using the inaccurate but practically usable rough relationship following:

Let the period in seconds equal T. Let the length between successive crests of the same wave train in feet equal L. Let the horizontal velocity of the wave in knots equal V. Then

$$V = 3T$$
$$L = 5T^2$$

- New waves are raised quickly to about ¾ of their ultimate height, which they then attain very slowly.
- The oceanographer's definition of wave height — mean of the highest 1/3 of waves observed — must be qualified with knowledge that 1/10 of the waves present will be half again as high and one in a hundred may be twice as high, and that there will also be areas relatively smooth.
- The practical open ocean sea condition must be assumed to be completely random with wave trains arriving from several directions less than 90 deg apart, and with differing velocities.
- That the moving sea will impose forces on even the drifting aircraft causing heave, roll, pitch, yaw, and slam. Means must be found to build adequate strength of shock struts or springs, or flexibility to protect the aircraft from damage.
- Under a wind of velocity V the theoretical maximum wave length in a fully developed sea is $L = 1.1\ V^2$.

more data needed

The bad blind spot in present knowledge of the sea surface as an aircraft landing surface is lack of real knowledge of the function of heave and slope, and the aircraft's response to these functions. With such knowledge we could proceed to response damping.

Much very accurate information is needed to establish figures on averages and extremes. Even approximations may be valuable.

Although description of a sea surface by its power spectrum may lead mathematically to power spectra describing the heave and various accelerations of an aircraft (at rest, or in motion on it) about its axis (pitch, roll, yaw), the validity of resultant computations on accelerations and inertia forces of the aircraft structure must be carefully verified in view of considerable differences between results from this approach and those obtained from the classical theory.

Certainly, thorough study of the sea surface appears desirable. Possibly nowhere in nature will we find systems of energy so completely random. Conclusions of Pierson and Neumann on probability distribution of wave heights are of immediate valuable application by seamen and seaplane pilots who will use them. Much other valuable usable information will probably come from further study.

Excerpts from an address by

Capt. Donald B. Mac Diarmid
operations officer, U. S. Coast Guard Eastern Area

Companies Organize for Weapon System Reliability

Based on report by secretary

K. R. McCready
Northrop Aircraft, Inc.

WEAPON SYSTEM RELIABILITY is becoming increasingly important. Therefore, it seems probable that the trend toward separate reliability organizations by military contractors will continue to increase. Whether or not these organizations will be of lasting importance depends to a large extent upon the intelligence applied by company managements in their establishment.

The needs of each company are different. They are influenced by the company's products, customers, and existing organization. Managements that conscientiously review their present organization to determine functions that need more attention for the assurance of a reliable product will be in a better position to establish a justifiable reliability organization that will in fact contribute to an improvement of the company product. Managements that form a reliability organization solely as a result of customer pressure are apt to find that an unjustifiable duplication of existing effort is the major result.

organizational and functional aspects of reliability control

Today, with the complexity of weapon systems skyrocketing, the importance of maintaining reliability has become a critical one. Thus, if reliability has reached a point of significance to deserve a separate organization of specialists set apart from regular design and manufacturing functions, what shall the responsibility and authority of the organization be? The industry, at this point, is searching for an answer.

Since reliability depends upon good design and proper assembly, it is implicit in the formation of a reliability organization that good designs and proper assembly must be enhanced by the formation of such a group, if its existence is to be justifiable. Many feel that a reliability organization should be staffed with better design engineers than those designing, better quality control personnel than those monitoring quality, and better manufacturing people than those manufacturing the product. This, however, wouldn't justify a reliability organization, since it would be more profitable from a reliability standpoint to have these people engaged in the design, manufacture, and quality control of the product.

Reliability personnel must, as a composite, have a broad background with specialists that in their field of specialization possess more knowledge and skill than their associates in design, manufacturing, and quality control.

The discussion of a reliability organization then resolves itself into one of specific functional requirements and the talents necessary to satisfy those requirements.

We will, therefore, give consideration to subsidiary functions that have been performed, to a degree, in the past by personnel primarily engaged in major functions related to design, manufacturing, or quality control.

customer–prime contractor aspect of reliability

The large number of failures of extremely expensive weapons has emphasized the need for establishing acceptable failure rates in weapon system specifications. Ignoring the first feeble attempts to specify reliability as an arbitrary percentage without specific criteria to be met, more and more weapon system contracts are being written that stipulate detailed service tests and specify the acceptable failure rates that can not be exceeded, if the product is to be judged reliable.

There is a need, due to increased specification of reliability, to analyze customer requirements and establish methods for measuring product reliability from design to final test to assure that the customer specification will be met. The early attempts at such analysis will be subject to considerable error. However, refinement gained by experience will lead to the development of techniques that will permit an economical trade-off of testing effort to reliability achievement.

You cannot test reliability into a product. Care must be taken, however, to avoid the erroneous collusion that testing does not lead to reliability. For it is only by correcting deficient designs or the causes of workmanship errors discovered during test that improvement in reliability can be achieved.

In the relationship between the customer and the

prime contractor, a growing need exists for the development of system and sub-system test requirements that can be correlated with customer reliability requirements. Through analysis of sub-system, system, and final weapon system test results, it must become possible to predict, measure, and bring to the attention of management the reliability status of a product from early design through field use to assure that contractual reliability commitments are met.

The analysis of customer reliability requirements, the translation of these requirements into system, and sub-system reliability requirements, the prediction and measurement of reliability growth, are functions that logically can be handled to advantage by a group of specialists.

prime contractor–vendor aspects of reliability

With the increased trend toward customer specification and control of reliability requirements in prime contracts, a need arises for a translation of these requirements into control of the reliability of sub-contracted items. At present, agreement does not exist as to the proper methods and procedures to be followed in making a suitable prime contractor-to-vendor translation of reliability requirements.

The problem is basically one of communication and economics. Multiple bidding requires extra care in communications between the prime and proposed sub-contractors. Unfortunately, in expedited programs, the communication links are often weak and specifications are not adequate. Communications, to be adequate, should be in the form of specifications defining in detail the test programs incumbent upon the supplier.

The procurement specification should stipulate the exact test equipment and calibration limits to be used for accepting the product. The complete detailed specification of tests, test procedures, and acceptance limits to assure the procurement of reliable items brings economics into the picture. Limited procurement, attendant with research and development programs, necessitates the amortization of testing cost over a relatively few items. In many instances, these increased costs have been deemed unjustifiable.

Reliability, rather than being assured through compliance with objective specification requirements has often been presumed from subjective personal evaluation of vendor products and procedures. Price has too often determined the supplier when only subjective evaluation was used. It is not clear in the industry today whether the most rewarding approach is through tighter specification, or through better subjective evaluation.

The problem of determining whether or not the vendor has met reliability requirements is a serious one. The establishment of a desired reliability number is relatively simple. The establishment of a confidence level for the attainment of that number becomes expensive. There have been isolated instances where 25,000 units have been built so that 24,000 can be tested to provide a high confidence level that the remaining 1,000 items are reliable. Present industry thinking is not sophisticated enough to adequately evaluate a wide scale approach of this nature.

Although the procedure for translating prime contractor reliability requirements into vendor requirements is not clear, it is becoming increasingly apparent that considerable specialized effort is required to establish adequate procedures.

design and assembly practices for reliability

In the design and assembly of any product, many factors can contribute to the reliability of the end item. Basically these factors involve the choice, proper application, and correct assembly of reliable parts. Although the choice of parts is a factor of design, each designer can not, in addition to his other responsibilities, be expected to have an expert knowledge of all available parts that might serve a given purpose. Each design engineer, without assistance, can not become aware of all of the peculiarities of each part he uses. By the same token, manufacturing personnel can not be expected to know all of the proper assembly and part installation techniques without specialized assistance. The above limitations of design engineers and factory personnel have led to the requirement for specialized parts application assistance.

Many companies have established organizations that specialize in providing pertinent information on the choice and proper application of reliable parts. The companies that have derived the most benefit from such programs have established laboratory evaluation and analysis of parts as an integral part of the parts application effort.

An effective parts application program requires a high degree of specialization. Part failures during prototype development, production, test and field operation must be carefully analyzed. These analyses must be augmented by laboratory evaluations of the same and "improved" parts to establish a professional knowledge of the modes of failure and methods to avoid failure occurrence.

The parts specialist, through his detailed knowledge of a rather limited field, can make substantial contributions to the reliability of the complete system by providing detailed information on the proper choice, application, and installation of its many parts.

In addition to contributing to the improvement of reliability, the parts specialist, through an accumulation and analysis of mode of failure and failure-rate data can provide valuable bases for the reliability prediction of new systems before the prototype has been developed.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: **W. E. Cox**, Northrop Aircraft, Inc.; **K. Warner**, North American Aviation, Inc.; **A. M. Small**, Convair Division of General Dynamics Corp.; **F. A. Alonso**, Lockheed Aircraft Corp.; **V. F. Simonick**, Douglas-Santa Monica; **C. L. Bates**, Ryan Aeronautical Co.; and **C. Wallace**, Hughes Aircraft Co.

Deposits Kill

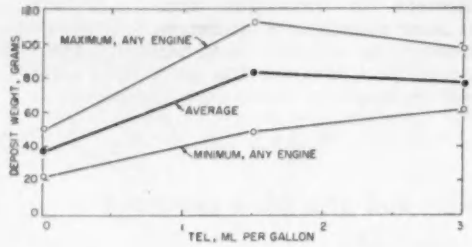
Based on paper by

E. C. Paige and H. T. Mueller

Research and Development Department, Ethyl Corp.

ALL ENGINES suffer from deposit power loss. But, power-loss effects are most severe in the constant-speed, constant-load service common to the auxiliary or utility-type engines. Since the greatest part of deposit power loss results from decreased air consumption, proper attention to engine design can go a long way toward reducing these losses.

The new multigraded oils may offer some relief from deposit problems because they form less resinous material. Carbon removal by physical or mechanical means also may be beneficial in some cases. Proper engine application and conscientious main-



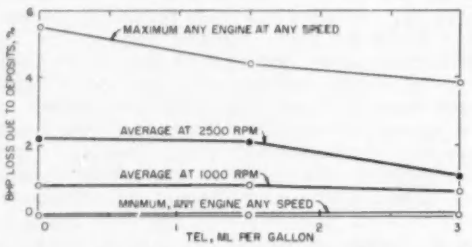
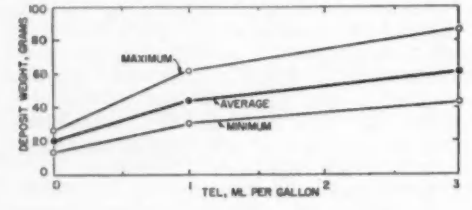

BHP LOSS DUE TO DEPOSITS, %
MAXIMUM ANY ENGINE AT ANY SPEED
AVERAGE AT 2500 RPM
AVERAGE AT 1000 RPM
MINIMUM, ANY ENGINE ANY SPEED
TEL, ML PER GALLON

Fig. 1 — Effect of fuel tel content on deposit weight and deposit power loss in heavy-duty truck operation.



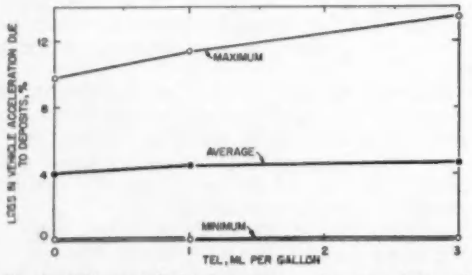
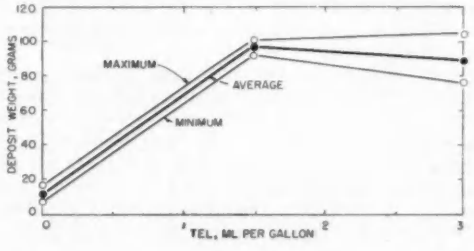


Fig. 2 — Effect of fuel tel content on deposit weight and on loss in vehicle acceleration in passenger car service.



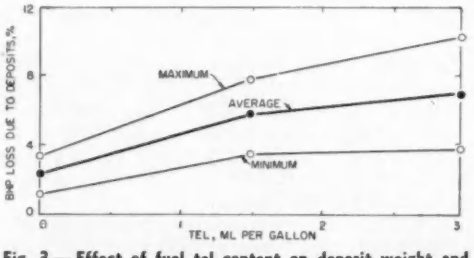


Fig. 3 — Effect of fuel tel content on deposit weight and deposit power loss in constant speed and load dynamometer tests.

Power in Utility Engines

tenance, however, can go a long way toward reducing deposits.

deposit

When hydrocarbon fuels such as gasoline are burned as fuel-air mixtures in engines, residual deposits are left on the surfaces of the combustion chamber. Contributing to the formation of these deposits is the partial combustion of lubricating oil that finds its way into the combustion chamber. The resinous deposits from partially burned motor oil are considered to be the materials that catch and hold the decomposition products to the cylinder walls.

causes of deposit power loss

Deposits cause power loss by reducing both thermal efficiency and volumetric efficiency or breathing capacity. Roughly two-thirds of the deposit power loss results from decreased air consumption, which in turn results from physical and thermal restriction of the intake charge.

Physical restrictions are a highly variable effect, and are dependent largely on engine design. Thermal restriction (reduction in the weight of the incoming charge caused by the transfer of heat from deposits to the charge) is also a highly variable effect. It too is dependent on engine design factors.

effect of tel concentration

Since the presence of tel in fuel increases deposit weight over that with clear fuel by several times, it is commonly believed that power loss also is increased several times. The effect of deposits on power loss is highly variable, however, and is almost entirely dependent on the type of service or engine operating conditions encountered. Consider three types of operating conditions:

1. Heavy-duty truck operation.
2. Normal passenger-car service.
3. Constant-speed and constant-load service such as operation of refrigerators, fans, pumps, or generators.

The effect of tel concentration on power loss in heavy-duty truck service is shown in Fig. 1. All engines were new at the start of the test. At the end of 15,000 miles of deposit accumulation, each engine was removed from its tractor and mounted on an engine dynamometer. Before-and-after deposit-removal studies were made at speeds ranging from 1000 rpm to 3000 rpm.

The power loss is plotted for both 1000 and 2500 rpm to show the effect of engine speed and also to make possible a comparison with constant speed operation. The values shown are an average for all vehicle operated on each tel concentration. The maximum and minimum power losses in any engine at any speed are also shown.

Power loss at 2500 rpm was about 2%, roughly double that at 1000 rpm. At either speed, however, the data show that the loss of power caused by deposits was independent of tel concentration. Although deposit weight is shown to be affected by tel concentration, it bears no relation to the observed power loss.

Sixty-six new passenger cars (operated in a fleet) were examined in a second test. The service, which included both city and suburban driving, was considered typical of normal "owner" operation. Each vehicle was operated for 12,500 miles at which time before-and-after deposit-removal tests were conducted. Included in the tests were observations of the time required to accelerate from 10–30 mph and from 10–50 mph. These observations, which provide a direct measure of the power loss, are shown in Fig. 2. Here again, note that tel concentration has an insignificant effect on power loss, and that deposit weight bears no relation to vehicle performance.

operation at constant speed and load

Because it is impractical to make direct power measurements of these engines when connected to their normal loading devices, these tests were conducted in the laboratory. The engines were the same makes and models as used in the truck test. Operating conditions were set to simulate field operation of equipment such as generators, blowers, and refrigerating equipment.

Fig. 3 shows the power loss and deposit weight as

Deposits Kill Power in Utility Engines

. . . continued

functions of tel concentration. As in the previous studies, maximum, minimum, and average values are shown. It is apparent that deposit power loss is affected by tel concentration in service of this type.

It is important at this point to remember that the average power loss due to deposits in truck service was about 2%. In passenger-car service the average loss was shown to be about 4%. In service at constant speed and load, including the effect of tel concentration, the loss is shown to be about 7%.

effect of operating conditions

The important effect of variations in operating conditions on the magnitude of deposit power loss is shown in the left-hand portion of Fig. 4. In these studies, all other variables were eliminated insofar as possible. Here, the relative power losses due to deposits are shown to be approximately 10%, 4%, and 2% for constant speed, cycling, and heavy-duty types of operation, respectively. Comparison of deposit effects when a wide variety of fuels and lubricants were used are shown in the right-hand portion of Fig. 4. Here, the relative amount of power loss is similar to that shown in the other portion of the figure where fuel and lubricant types were controlled. However, the absolute magnitude of the effect is somewhat greater.

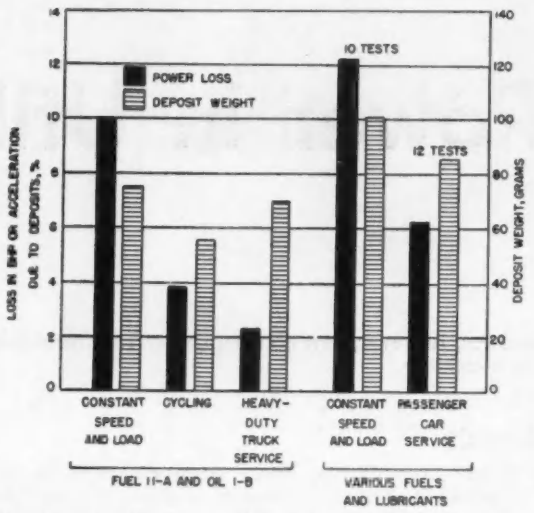


Fig. 4 — Effect of various operating conditions on deposit power loss and deposit weight.

engine design

Of all the factors that may influence the magnitude of power loss effects due to combustion chamber deposits, engine design is probably the most important. The effects of combustion chamber design are shown in Fig. 5. Four different engines were used in this investigation. Two engines were of L-head design and two were of overhead-valve design. The general superiority of the overhead-valve design is clearly shown. Also, certain designs within each of these two general design classifications are definitely superior.

This was more clearly defined in a series of tests of a certain small single-cylinder L-head engine. As received, this engine could not produce rated power after 150 hr of constant-speed operation. Investigation showed that deposits in the block around the intake valve reduced the effective valve opening and caused physical restriction of the incoming charge. The condition was remedied by increasing the valve lift from 1/8 in. to 3/16 in., with the result that power loss was insignificant even after 1000 hr. operation. Here is definite evidence that minor design details can have major effects on deposit power loss. It is also further proof that both good and poor designs are possible regardless of the basic engine configuration.

lubricating oil

Tests have shown that the choice of motor oil may affect the engine octane requirement to a marked extent. Therefore, it is natural to suspect that the choice of motor oil also may affect deposit power loss. Tests have confirmed this suspicion. The data shown in Fig. 6 indicate the probable extremes that may be expected in the effect of deposits on power loss when using commercial-type lubricants. Many oils having characteristics similar to those of oil 4A are now commercially available. It would seem desirable to use oils of this type in utility engines.

physical carbon removers

At present, we know of only one device that offers possibilities of carbon removal by physical or mechanical action. This device is used by many laboratories to remove combustion chamber deposits from the CFR engines which determine the octane numbers of motor fuels. Deposit removal is accomplished by blasting the deposits loose by means of compressed air and some material that will not

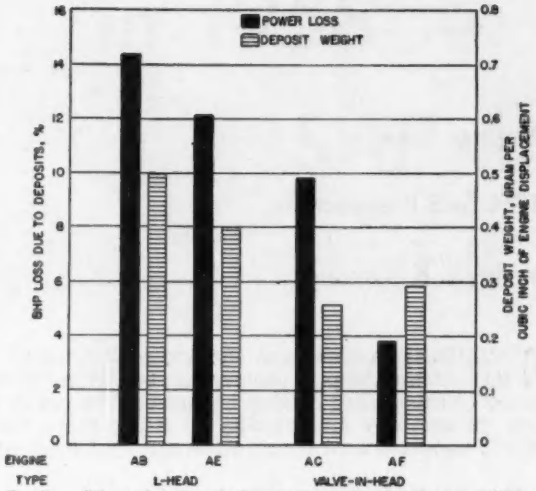


Fig. 5 — Effect of design on deposit power loss in tractor engines.

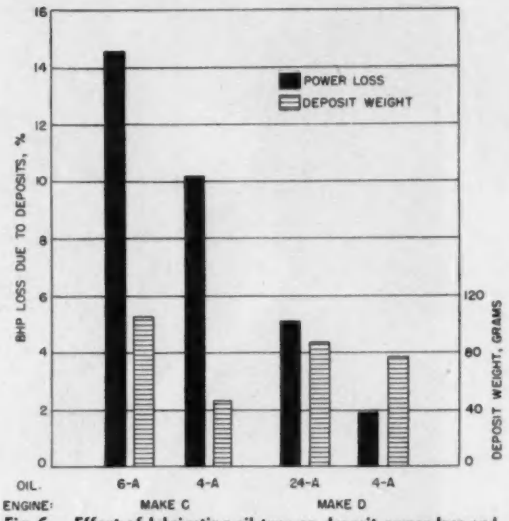


Fig. 6 — Effect of lubricating oil type on deposit power loss and deposit weight.

harm the engine. Materials used have been rice and finely ground walnut shells. This method of carbon removal might be practical for use by some large fleets.

choice of engine

Choosing the proper engine for an application will relieve deposit problems. For example, in one operation, 9.5 hp was required to operate a compressor. The engine chosen would produce 11.0 hp when it was clean and operating at best efficiency. Deposit power loss and other maintenance deficiencies caused difficulty in many cases after 300–500 hr of operation. The removal of a 50-amp generator, which was being driven by the engine unnecessarily, provided a reserve of power and improved the operation. Subsequently, a larger engine of the same design was used to power similar equipment. This provided troublefree service for periods ranging from 1500 –3000 hr.

general maintenance

In many instances, lack of satisfactory maintenance is responsible for many of the complaints attributed to deposit power loss. Even when adequate maintenance schedules are programmed, shop personnel frequently will not touch the utility engine if time runs short during an inspection period. In one operation having serious complaints of deposit power loss in air-conditioning engines, arrangements were made to test a carbon-remover fluid at the request of the fleet operator. Forty vehicles were chosen for the test. Twenty were to receive regularly scheduled treatments and the other twenty were to receive normal routine maintenance services. At the end of a six-month trial period, the shop records revealed that not one engine of the forty had received any maintenance service (except oil change done by another group) unless the equipment failed to operate.

In another operation having complaints of deposit power loss, the fleet management insisted that prearranged maintenance programs be carried out during the test period. Although the results indicated little advantage for the use of the carbon remover, observance of a good maintenance program significantly improved the general fleet operation.

To Order Paper No. 97A . . .
. . . on which this article is based, turn to page 6.

Message from

1958 SAE President

William K. Creson

OUTLINING in cold type the accomplishments of SAE during the past year, as has been done in the pages of this report, doesn't begin to tell the story of the productivity and vitality of SAE's more than 23,000 members and nearly 5,000 Enrolled Students.

To have been upon the SAE scene at this point in its history has been an extreme pleasure and a privilege for me. Visits with members in 31 Sections throughout the country, with students and teachers at more than 50 universities and colleges at which we have Enrolled Students, and attendance at 8 National Meetings, assures me that the Society is in a healthy, sound condition. One observation I have made and had confirmed in my 35,000 miles of SAE travel during this year is that the bigger the man, the more ready he is to learn, and the more willing he is to teach others. SAE is composed of countless such men.

Outstanding in this year's many accomplishments has been the completion of the work of the Planning for Progress Committee. Council's acceptance of the Planning for Progress Committee's report sets the stage for submission to the membership of the required Constitutional amendments to encompass the proposed structure. Equipped with the effective structure being proposed to the membership, the Society is on the threshold of a new era of growth and improved and expanded services to its members.

Exposure to our members at work, in their plants and at their Section Meetings and at National Meetings, convinces me that they are involved in a rapidly changing technology . . . be they in the passenger car field, in aircraft, in design of construction and industrial machinery, or in the improvement of the fuels and lubricants and materials used in the construction of these and similar machines. More than ever, they are thirsty for new knowledge in these fast developing technical areas. They are eager to exchange information on technical problems with fellow engineers. Their search for new information, rapidly communicated, creates new potentials in service for SAE.

One reaction among many significant ones stands out from my contacts with our members and the Society at work during the year. It's this: The Society's greatest single asset is its individual members — the thousands of members who participate in the Society's work and who partake of the technical services, together with the many hundreds of competent, sound men who lead the work of the Society, assure SAE of a continuing, stable and brilliant future.

In 1958 — SAE Made and Planned for Progress

During the past year, the Society and many of its groups were tuning in their operations to the Planning for Progress reorganization plans.

In addition to carrying on their normal business, many committees were working directly with the Planning for Progress Committee in helping develop and detail the proposed reorganization of the Society.

At the same time many of these groups were preparing themselves by planning their own operations so as to make for a smooth transition into the new structure.

1958 was a significant year for SAE Council. Like previous Councils, it guided the Society's work by dealing with the recommendations and progress reports from its committees, by developing policies, and by taking action on normal Society business. But in addition, the 1958 Council spent considerable time in reviewing a major proposal which came to its attention. That proposal was the report which the Planning for Progress Committee brought to the September 7 Council meeting in Chicago. A complete exposition and careful consideration of the Planning for Progress report resulted in its acceptance by Council. By approving the report, Council agreed to submit to the membership the proposed Constitutional amendments required to bring about the PFP proposal.

Because of the importance of the decision to be made, President Creson invited the nominees for the 1959 Council to the September 7 meeting at which the Planning for Progress proposal was to be considered. These men participated in the discussion and in the deliberations that led to Council's acceptance of the report.

Among other interesting projects that Council considered and acted upon during the year was a recommendation of its Executive Committee that Honorary Member grade be activated and that the Constitution be amended accordingly. As a result of this action, it was agreed by Council that Past-Presidents be given Honorary Membership instead of Life Membership at the termination of their service on the Council. It was further agreed by Council that Honorary Member grade be confined to Past-Presidents and that life membership be deleted from the Constitution.

Council felt that necessary steps should be taken to define life membership as a method of paying dues for life rather than grade of membership. Currently, life membership is a form of recognition given to Past-Presidents. It is also a method of paying dues for life on an actuarial basis.

The Constitutional amendments to be considered at the 1959 Annual Business Meeting incorporate proposed changes on both the Honorary Member grade and life membership.

Early in the year, Council created a new way in which to recognize the Society's Past-Presidents. It took the form of a special Past-Presidents' pin, approved by Council, as a token of esteem from the Society to its Past-Presidents for their services. The Past-Presidents' pin is similar to the regular SAE emblem in both shape and design, although it's slightly larger. The pin has a dark blue enamel background with a small diamond in the center and is of 14 kt. gold.

Much of Council's work concerned itself with the normal consideration of recommendations and reports made by Council's standing committees. Typical of these were the report of the Finance Committee, which was presented at the fall meeting of Council. This report, accepted by Council, recom-

C. C. Dybvig
Chairman
Constitution Committee

A. T. Colwell
Chairman
Finance Committee

A. O. Willey
Chairman
Meetings Committee

J. H. Dunn
Chairman
Membership Committee

A. R. Hempe, Jr.
Chairman
Placement Committee

W. H. Graves
Chairman
Public Relations Committee

In 1958 — SAE Made and Planned for Progress

. . . continued

mended the Society's budget for the coming year as well as the fiscal program. Also included among these reports were those of the Membership Grading Committee covering recommendations on applicants to membership and for grade transfers.

In 1958, Council not only concerned itself with the operations and programs within the Society, but also took action with regard to the Society's cooperation and coordination with other organizations and groups. For example SAE was asked to nominate a man to serve as Director on the Board of Directors of the American Standards Association for a two-year term starting January, 1959. Council approved the nomination of H. E. Chesebrough to that post. In a similar vein, three men were appointed by Council as SAE nominated Directors on the CRC Board of Directors.

From time to time, Council is called upon to make a decision with regard to requests from other organizations for joint SAE participation in meetings of other groups. Council always weighs these proposals in terms of the amount of energy, effort, and dollars required on the part of SAE as against value to the Society membership. Council also examines the feasibility of such joint participation in terms of SAE's Constitution as well as policies, philosophies, and traditions. At least one invitation to the Society to co-sponsor an unrelated event failed to meet these criteria and was turned down by the 1958 Council.

Much of Council's work and coordination with its standing committees is best described in the portions of the report that follow on the varied operating programs of the Society.

Meetings Serve Members' Technical Interests

Technical information tailored to the interests and changing requirements of SAE members has continued to be the objective of the groups responsible for programming National Meetings. Through extensive discussion of problem areas last year, the 12 professional Activities arranged for presentation of 307 papers at 109 technical sessions, and for detailed discussion of specific topics at 42 panel sessions. Continued improvement of technical content

was evidenced by the animated discussions of the papers presented.

Each of the 12 professional Activities, in using the various outlets for the dissemination of information, has brought to SAE members in all technical areas, new and vital material on today's developments, techniques, and problems and, at the same time, has opened the door to tomorrow's horizons. Some of the major fields focussed upon by the Activities are shown below:

Air Transport — Adapting today's procedures and developing new methods for operating and servicing the new jet transports.

Aircraft — Development of information needed by the engineer to change his technical activity from manned aircraft to missiles.

Aircraft Powerplant — Advanced forms of flight vehicle propulsion.

Body — Structural design configurations and needs for automobile bodies, noise reductions, styling and seating.

Diesel Engine — Turbocharging existing and newly developed engines, establishing horsepower ratings, and the use of computers in engine design.

Engineering Materials — Plating, developments in steel making, aluminum uses, materials of the future and their application to tires and brakes.

Fuels and Lubricants — Lubricant trends and performance, requirements of fuel, additives, engine rumble, and antiknock.

Passenger Car — Safety, relationship of highways to design, overseas developments, noise and vibration, small cars, and air suspension.

Production — Adaptation of information on: automation, quality control, procurement, cost control, computers for production, and material processing techniques; for use in the automobile, truck, bus, tractor, construction equipment, and aeronautical industries.

Tractor and Farm Machinery — Engines and air cleaners, drive-line components, hydraulic systems, equipment testing procedures, and trends in new farm and construction machinery developments.

Transportation and Maintenance — Truck performance predictions, fleet maintenance, small auxiliary engines for refrigeration and public utility applications.

Truck and Bus — Cab design considerations, power control systems, truck ride suspension, heavy duty brakes, truck noise, and cooling systems.

The Planning for Progress concept of operation is already playing a large part in program planning in the development of improved technical content of papers. The two National Aeronautic Meetings and the West Coast Meeting are being programmed by general committees that are drawing manpower and subject areas from the participating Activities. The Activity Committees, thus freed of the detailed arrangements, are looking into the future, studying problems, and developing reports. Many of their discussions will lead to further improvements in the technical programs of tomorrow.

The Special Advisory Committees to the SAE President have increased their contributions to SAE members by developing technical programs and reports in new and specific areas. Sixty-five pages of the SAE Journal have been devoted to overseas material containing information on such subjects as European steel manufacturing, German universal joints, and Russia's turboprop transport. The Committee has also assisted indirectly in obtaining meetings papers on overseas subjects.

The Nuclear Energy Advisory Committee has furnished information on radioactivity as a tool and new jobs for the atom. Under development is a program to bring SAE members detailed technical

P. F. Allmendinger
Chairman
Student Committee

T. R. Thoren
Chairman
Sections Committee

Leonard Raymond
Chairman
Publication Committee

O. K. Kelley
Chairman
Technical Board

In 1958 — SAE Made and Planned for Progress

. . . continued

material on radioisotope applications. Reports to the Committee have appeared as Nuclear News Notes in each issue of the SAE Journal. Research and Science are being brought into focus by the Science-Engineering Advisory Committee, which has already presented technical sessions and panels. All SAE members are concerned with measuring things — performance, dimensions, strength, etc. The Committee is developing a series of reports and programs to explore this fundamental science.

The Missiles Advisory Committee and the Computer Advisory Committee are continuing to cooperate with various Activities in developing information desired by the SAE engineer. Through the assistance of the Utility Engine Advisory Committee, new and valuable information on small engines has been made available to the users.

During the year the information development groups have submitted periodic reports to the Council in order to provide guidance for policy decisions and to obtain approval for future programs. Based upon recommendations of the SAE Meetings Committee, the Council approved dates and locations for 11 National Meetings for 1959. The Council also approved the holding of closed sessions at the 1958 National Aeronautic Meeting held in Los Angeles and the modification of the name of the Meeting. Reports of the Advisory Committees and their membership have been reviewed and approved.

Publication Policies Updated

Updating of its publication policies and operating procedures to fit expected changes in the Publication Committee's responsibilities was a major Committee activity in 1958.

Through this updating, the Committee has readied itself to:

a. Take responsibility for business as well as editorial phases of publication development — as suggested in By-Law changes currently under Council consideration, and

b. Provide effective and feasible means to attain maximum member values in distribution of the technical information destined to emanate from all Society sources under the structure proposed by the Planning for Progress Committee.

The Publication Committee has also completed the preliminary phases of a long-range financial planning project. This was developed at the request of the Finance Committee for later coordination with the long-range financial planning project for the Society.

Throughout its 1958 activity, the Publication Committee has aimed at maintaining existing publication services at normal levels as regards quantity of material published; at steadily increasing the average of quality; and at preparing for the increased opportunities for service to members which the proposed revised Society structure bids fair to bring.

Membership Up Again

Although SAE membership continued its upward swing in 1958, the rate of advance was slowed, reflecting general conditions in many of the fields employing SAE members. The Society closed its fiscal year with a record membership of 23,442, an advance over the previous all time high of 22,734 reached at the close of the previous fiscal year. Additions during the year totaled 2,373 (names of newly qualified members are listed in the Journal) while separations numbered 1,664, for a net gain of 708. The end of the year count showed:

	1957	1958
Member	13,746	14,471
Associate	5,195	5,244
Junior	3,793	3,727
Total	22,734	23,442

The 1958 fiscal year recorded a general slow-up in new applications which may have a noticeable effect on the number of new members added during the coming year.

Recognition certificates are being distributed through Sections to 93 members who have completed 25 years of active membership, 72 members who have completed 35 years, and 6 who have rounded out 50 years of membership in the Society. Those celebrating their Golden Anniversaries are:

Frederick Charavay — Dayton Section
George M. Holley — Detroit Section
Frederick Ewan Moskovics — Metropolitan Section
Charles S. Mott — Mid-Michigan Section
Julian Chase — Southern New England Section
Guy W. Vaughan — Southern New England Section

"SAE Membership Handbook," a guidebook for those active on Section and National membership committees, was published early in the year. Work is nearing completion on a new folder designed particularly to explain the advantages of Society membership to prospective members in the area of fuels and lubricants. Another specialized promotion piece is the "Missiles Newsletter" of which four editions have been circulated to membership committee workers and others during the year.

The Council took specific action approving minor changes in the Society's policies covering delinquent members, the most important of which was to eliminate a 30-day grace period for members delinquent in dues and dropped as of September 30, to pay past dues and have dropping action rescinded. The Council also confirmed its past policy covering action on members who are delinquent in notes given in payment of initiation fees and first year dues.

An important project of the Membership Committee has been to visualize its responsibilities under the Planning for Progress program and to recommend the committee's possible organization and areas of operation in anticipation of adoption of the proposed plan for the Society.

Membership Grading Committee

The Membership Grading Committee, which makes recommendations to the Council on elections to membership and transfers of membership grade, had another busy year reviewing some 2,027 applications for membership and 534 applications for transfer. Included were applications from 42 applicants who were not recommended for membership because of insufficient technical training and experience. Upon the recommendation of the Membership Grading Committee, the Council took action to elect 902 persons to Member grade, 440 to Associate grade, and 643 to Junior grade.

Sections Have Good Year

SAE Sections and Groups had another constructive year with prime emphasis on the development and presentation of meeting programs shaped to the interests of the local members. Besides scheduling regular monthly meetings, a number of Sections held special one-, two-, and three-day meetings, staged seminars or forums of specialized interest, or sponsored educational courses. Many Sections also worked directly with SAE Student Branches in their areas, helping to supply speakers for Branch Meetings. They also brought students together for special Section-Sponsored Student Meetings.

A great assist to Section officers and committee chairmen was the new and greatly revised SAE Section Procedure which is a compact handbook outlining Section objectives, officer and committee responsibilities, and recommendations for meetings and meeting arrangements. Section Procedure was prepared by a special committee of the Sections Committee Executive Committee and was approved by Council action.

The Sections Committee Executive Committee worked closely with the Student Committee Executive Committee in formulating proposed rules and regulations for the projected Sections Board and in giving Section and Group Governing Boards an insight into the Planning for Progress program.

The Committee, in its advisory capacity to the Council, recommended, and the Council acted favorably on:

- Requests of the Indiana Section for additional Vice-Chairmen and extension of territory
- Petition of the San Diego Section for permission to purchase an exhibit booth
- Request of Alberta Group for permission to re-elect its Chairman
- Detroit Section request for authority to change the name of its "Aeronautic Activity" to "Aeronautic and Missile Activity"
- Continuation of local affiliations of seven Sections with local engineers' clubs or technical society organizations
- Proposal that the President be authorized to appoint a committee to consider the matter of establishing local SAE units overseas

  (In this connection the Committee recommended that a group of members in Brazil organize informally to gather occasionally for discussion of topics of mutual interest.)

At the suggestion of the Sections Committee Executive Committee, the Council acted not to authorize the Texas Gulf Coast Section to add a Vice-Chairman representing Passenger Cars to its elective officers, due to the fact that there are few members in the area engaged directly in the design of passenger cars, and that there are no passenger car production or assembly plants within the Section territory.

Student Activity at Peak

Georgia Institute of Technology, Marquette University, and the University of Saskatchewan were officially added to the list of schools at which SAE has Student Branches. The addition of these new branches by Council brought the number of active Student Branches to 56. Informal SAE student clubs are active at 11 schools and are potential Student Branches. Altogether, SAE has 4,768 SAE Enrolled Students taking engineering courses at 117 colleges during 1958.

As evidence of President Creson's active interest in the Society's student program, he made a special point of visiting with students and faculty members at more than 50 colleges and universities during the year. In many instances he met with Student Branches and gave them a picture of "Tomorrow's Engineer." No other President has taken such an active interest in SAE students and their future.

To help Section Student Chairmen and others who are talking SAE with college teachers and administrators, the Student Committee has prepared a brochure, "SAE Student Story," geared directly to this audience. Copies may be obtained from SAE Headquarters.

Another student aid has been the "SAE Student-Gram" circulated periodically to carry information to Student Branch Faculty Advisors, Student Branch Chairmen, and Section Student Chairmen.

Graduating SAE Enrolled Students who applied for membership numbered 498, accounting for 22.5% of the applications for membership received during the fiscal year.

The Student Committee Executive Committee has joined with the Sections Committee Executive Committee in planning ahead for the new Sections Board, visualized under Planning for Progress, which will embrace the activities of these two committees. Together they have worked out tentative rules governing the Sections Board operations and programs for advancement of Student and Section programs. Joint activities also have included a program to bring information on Planning for Progress to the Governing Boards of the various Sections and Groups.

Constitutional Areas of Operation

SAE Sections and the Society itself quite often receive invitations to participate in activites which

Continued on page 92

B. B. Bachman
Treasurer

Sound Financing Is Essential

The SAE Finance Committee has been following closely the forward-looking efforts of the Planning for Progress Committee. It recognizes that adequate dollars must be provided to encompass the prospective growth in membership, the increasing scope of activities, and the generally increasing cost of doing business.

To meet these needs the Finance Committee is working on a long-range financial plan which it hopes to have functioning by 1960. It will be a 10-year projection; kept up to date annually. The idea is that, after three or four years' experience, Finance Committee forecasts can be made reasonably accurate. Furthermore, a long-range plan should permit more orderly programming of Society services; fitted to longer term swings in the economy rather than intermediate corrections.

This past year has pointed up the need for a plan quite well. In fact, the impact of the recession caused a Budget review which caused a downward readjustment of spending plans by some $70,000. As a result, year-end figures showed the Society to be $37,968 in the black for operations during the fiscal year — only some $2,000 below original Budget estimates.

After appropriate allocations of general and Administrative expenses, the Member Service area was some $20,000 in the black and the Cooperative Engineering Program was nearly $18,000 in the black.

Although the Society's operations show a surplus of $37,968 for the fiscal year, only $24,889 was transferred to the general fund since a net loss of $13,079 was realized on the sale of securities.

In preparing its 1958–59 Budget, the Finance Committee and Council decided to predict income conservatively because of the uncertainty of the general economy. However, it was also decided not to do anything to hamper the increasing scope of SAE endeavor either in existing activities or the newly developing elements. Therefore, the estimate was for a final red figure of $28,000 for the 1958–59 Budget.

Inasmuch as the economic skies seem to be clearing, it is now hoped that final results will be considerably better than the Budget indicates.

Council approvals during the year included:

1. A $5 guest registration fee was established for all National Meetings except Annual and Summer Meetings, which remain respectively at $10 and $15.

2. The Investment Program derived a little more income through putting available cash into short term Treasury Bills — considered the equivalent of cash.

3. Provisions of the SAE Retirement Plan were changed as follows:
   a. Certain optional privileges were added with no additional cost to the Society.
   b. An incentive feature was installed to permit advertising salesmen to enhance their retirement annuities through their own efforts.
   c. The maximum annuity provision was deleted.
   d. Entry into the plan now requires the reaching of age 25 as well as two years of SAE service.

4. Hospitalization and Group Insurance will now be carried for retired employees. The former will be entirely at the expense of the individual. The latter requires a small outlay by SAE because, by law, the maximum charge to an individual is 60¢ per month for Group Insurance.

5. Price increases were approved as follows:
   a. Annual subscription price for the Journal to outsiders was increased from $10 to $12.
   b. Price of Handbooks to members went from $1 to $3.50. Quantity rates were also established.
   c. Handbook advertising rates were increased from $350 to $400 per page.

Financial Statements for the 1957–58 Fiscal Year are incorporated in this report and are in line with the Haskins & Sells audited report. At the September 30 year end, the audited statement shows General Reserves of over $1,000,000. Investments totaled $988,000 at Book Value and $1,462,000 at Market Value.

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

67 BROAD STREET
NEW YORK 4

ACCOUNTANTS' CERTIFICATE

Society of Automotive Engineers, Inc.:

We have examined the balance sheet of the Society of Automotive Engineers, Inc. as of September 30, 1958 and the related statement of income and expenses, and general fund, for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statement of income and expenses, and general fund, present fairly the financial position of the Society at September 30, 1958 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

November 14, 1958.

Haskins & Sells

Balance Sheet

September 30, 1958

Assets

General Cash		$ 274,298
Restricted Funds:		
Cash (Including $13,490 in Savings Banks)	$ 14,741	
Securities (Market Value $18,097)	17,915	32,656
Receivables (Less $3,273 Reserves)		22,453
Investment Funds:		
Investments at Cost	* 1,088,374	
Cash	7,020	
Accrued Interest	5,175	1,100,569
Inventories (Principally at Cost)		37,710
Furniture & Fixtures (Arbitrary Value)		1,000
Prepaid Expenses		77,614
Total		$1,546,300

Liabilities

Accounts Payable		$ 52,525
Section Dues Payable		34,935
Deferred Income:		
Dues Received in Advance	$ 290,374	
Journal Subscriptions	10,414	
Transactions	7,978	
Handbook	20,968	
Dinners and Displays	49,754	
Other	5,363	384,851
Restricted Funds:		
Memorial Funds	14,053	
Other	18,603	32,656
General Fund		1,041,333
Total		$1,546,300

* Market Values at September 30, 1958	Market	Cost
U.S. Government Bonds	$ 107,076	$ 124,311
U.S. Government Discount Bills	99,383	99,400
Corporate Bonds	350,525	363,750
Common Stocks	898,663	500,913
Total	$1,455,647	$1,088,374

Statement of Income and

For Year Ended

Income

Membership		
Dues and Journal Subscriptions	$521,152	
Initiation Fees	37,527	
Emblem Sales	1,736	$ 560,415
Publications		
Journal Sales	24,730	
Journal Advertising Sales	517,487	
Handbook Sales	24,545	
Transactions Sales	34,815	
Special Publications Sales	78,972	680,549
National Meetings		
Guest Registration Fees	14,275	
Dinners and Luncheons	37,869	
Displays	94,990	
Summer Meeting Registration Fees	7,882	155,016
Cooperative Engineering Program		
Aeronautical Specifications, etc. — Sales	73,466	
Industry Contributions	305,570	379,036
Investments		
Interest	18,328	
Dividends	21,880	40,208
Cash Discounts Earned		1,502
Total Income		$1,816,726

Expenses, and General Fund

September 30, 1958

Expenses

Sections and Membership		
Sections Department	$ 16,625	
Sections Dues and Appropriations	84,609	
Membership and Student Department	63,158	
Miscellaneous Membership Expenses	1,410	$ 165,802
Western Branch Office		32,227
Publications		
Journal — Production and Mailing — Editorial	190,378	
Roster (13th Journal Issue)	40,557	
Journal Advertising	265,158	
Handbook — Mailing	2,732	
Transactions — Production and Mailing	57,653	
Special Publications	48,223	604,701
National Meetings and Information Development		
Division Salaries and Expenses	73,308	
Meetings Operations Department Expenses	1,401	
Guest Registrations	2,476	
Meetings	25,099	
Dinners and Luncheons	42,201	
Displays	20,907	
Meetings Program Department	20,695	
Professional Activity Department: Activity Committees	6,894	
Awards	340	193,321
Cooperative Engineering Program		
Aeronautical Specifications, etc.	33,514	
Technical Committees	162,142	
Handbook Editorial Salaries & Expense	14,787	
CRC Appropriation	30,000	
Solicitation of Industry Contributions	14,058	254,501
General Management and Administrative (See proration on next page)		
General Management	132,037	
Council and Committees	9,427	
Administrative	61,987	
Service Departments	157,399	
Furniture and Fixtures	13,644	
Rent and Light	80,148	
Retirement Plan and other employee benefits	66,850	
Miscellaneous	6,714	528,206
Total Expenses		1,778,758
Excess of Income over Expenses (before Loss on Sale of Investments)		37,968
Net Loss on Sale of Investments		13,079
Excess of Income over Expenses and Loss on Sale of Investments		24,889
General Fund at Beginning of Year		1,016,444
General Fund at End of Year		$1,041,333

PRORATION OF GENERAL MANAGEMENT AND ADMINISTRATIVE EXPENSES TO DIVISIONS

To	%	Expense Proration	Direct Division Expenses	Total
Sections and Membership	13.3	$ 70,251	$ 165,802	$ 236,053
Western Branch Office	2.6	13,733	32,227	45,960
Publications	48.3	255,124	604,701	859,825
National Meetings and Information Development	15.5	81,872	193,321	275,193
Cooperative Engineering Program	20.3	107,226	254,501	361,727
TOTALS	100%	$528,206	$1,250,552	$1,778,758

In 1958 — SAE Made and Planned for Progress

. . . continued from page 87

may or may not be within the Society's proper sphere of operation. A special Committee on Interpretation of the Society's Constitutional Areas of Operation has been working toward the development of guideposts which will assist Society and Section Officers to determine whether proposed activities come within the Society's scope.

Placement Service Keeps Pace

The Council reacted favorably to the bulletin of SAE Consultants which was compiled for the first time in 1958. Its appeal was primarily to older men and carried 136 names. It was a needed addition to the service because of the increasing age of SAE's effective membership and the fact that so many were not "old" when their company retirement plans caught up with them.

In line with the times, job openings declined early in 1958 while the number of job seekers increased. By fall, however, everything was back to the 1957 level.

The Service helped some 70% of its registrants into new connections. An average of 7 contacts was made per listing and some individuals made as many as 25.

The cost of this "free" Service amounts annually to 39¢ per member.

Technical Board Improves Structure

In the spirit of Planning for Progress, the Technical Board in 1958 planned a reorganization of its operation, aimed at better serving the needs of industry and of SAE technical committees.

Under the proposed plan, the Board would establish four "Councils of the Board" and give them authority to approve, in behalf of the Board, reports generated by its technical committees. With fewer groups reporting directly, more time would be available to the Board to render general supervision and policy guidance to the overall Cooperative Engineering Program.

Among this year's Technical Board achievements are the following:

- Revision of school bus and emergency vehicle stop light, turn signal, and warning signal light standards to increase signal lamp effectiveness — accomplished as a result of extensive tests.
- Revision of standard for sealed beam units as a result of new dual unit lighting system designs.
- Development of a uniform method of comparing brake lining quality — in the form of a quality control test procedure.
- Higher rpm power take-off standards prepared to meet requirements resulting from increased horsepower of farm tractors — accomplished in cooperation with Farm Equipment Institute.
- Storage Battery Standard brought up to date to include the latest information on 12-volt batteries and establish minimum current (amp) values at 0 F.
- Nomenclature for front end shovels and loaders standardized to facilitate the exchange of technical information.
- Standard measurement of radio interference (30 to 400 megacycles) revised to incorporate "Limits."
- 160 new and revised Aeronautical Material Specifications (AMS) published bringing the total of such documents to 835 — almost 11,000,000 AMS have been purchased for use by the aircraft, missile, and rocket industries.
- Recommended Practice for training of civil transport crews in aeromedical aspects of flight, prepared, to aid in familiarization with the use of oxygen equipment in aircraft operating above 25,000 ft.
- Cockpit nomenclature and abbreviations standardized to improve uniformity of language and identification.
- Completion of a test code for evaluation of lube oil filter performance.

• Revision of the hydraulic brake fluid standard to incorporate a new heavy duty fluid with a minimum boiling point of 375 F.

Some of the new activities started by the Technical Board are:

• A Brake Committee to develop rating procedures for hand brakes — necessitated by the advent of automatic transmissions.

• An Air Spring Subcommittee to consider the development of technical material on new types of suspension.

• A joint Truck and Bus and Transportation and Maintenance Subcommittee formed to review use of kingpin couplings and drawbar connections in truck, tractor, and trailer combinations.

• A subcommittee to investigate standardization of gross vehicle weight ratings as currently used by industry.

• Aircraft and Missile Support Equipment Committee formed to study possible standardization and preparation of realistic support equipment requirements.

• Aircraft Lighting Committee organized to investigate standardization of flight crew station, exterior and interior aircraft lighting.

A new SAE Handbook publication concept has been established which will result in a more editorially consistent book. A special Board group has prepared written guides for, and will work with technical committees on, the preparation of uniform, high quality, and timely reports.

To keep the Society's membership abreast of the activities of the Cooperative Engineering Program, the SAE Journal has expanded its coverage of technical committee progress. The technical committees, aware of the values from Journal coverage of their work, are devoting more effort to explaining the significance of their work.

The SAE Technical Board continues to keep pace with industry's progress and needs. Through its planned reorganization it hopes to expedite the preparation and publication of material prepared by its technical committees. Through its Councils, it hopes to give industry more specialized technical assistance.

Where SAE Funds Came From . . .

30.8%	Membership Fees and Dues
37.5%	Publications Sales, Including Advertising
8.5%	Registration Fees, Dinners, and Displays at National Meetings
20.9%	Cooperative Engineering Program, Including Industry Contributions
2.3%	Investment Income and Cash Discounts

. . . And Where They Went . . .

Sections and Membership Expenses	x15.5%
Publications, Including Advertising	x47.3%
National Meetings, Dinners, Displays and Information Development	x 15.2%
Cooperative Engineering Program	x 19.9%
Loss on Sale of Investments	.7%
Excess Income Added to General Fund	1.4%

x Including prorated share of General Management and Administrative expenses.

About SAE Members

CLARK L. HASTINGS has been elected president of Rochester Mfg. Co. He was formerly vice-president in charge of sales and advertising for the company. Hastings joined RMC in 1928. In 1938, he was made vice-president and sales manager. Earlier this year he became president of RMC of California while continuing as company vice-president.

Hastings

Reeves

E. DUER REEVES has been elected executive vice-president of Esso Standard Oil Co. He also has been elected director and vice-chairman of the executive committee of the Esso board. Since 1949, he has served as executive vice-president for Esso Research and Engineering Co.

WILLIAM L. MITCHELL has been named vice-president in charge of GM Styling Staff, General Motors Corp. Mitchell has been director of GM styling since 1954. He has been with GM since 1935 when he joined the Styling Section.

Mitchell

Miller

FRED F. MILLER has been made vice-president in charge of engineering of Gear Grinding Machine Co., Detroit. Miller formerly was vice-president of Detroit Bevel Gear Co., until recently a Gear Grinding subsidiary.

JACK H. ZILLMAN has been made general manager of Daystrom Pacific Division, Daystrom, Inc. He will be responsible for expanding the company through research and development of new product and system concepts. Zillman was president of Whirlajet, Inc., and manager of U.S. Industries Research and Development Corp.

Zillman

Panier

G. A. PANIER has been named assistant general manager, Division of Basic Products of Simca, Inc., in France. Formerly, he was executive manager of the Mercury Division of Ford Motor Co.

Norton

Fischer

ROY C. NORTON, JR. has been named chief engineer of Saco-Lowell Automotive Division, Saco-Lowell Shops. He was formerly director of engineering for Long Mfg. Division, Borg-Warner Corp.

LAWRENCE W. FISCHER has become executive sales engineer on the automotive general sales staff of Bendix Products Division, Bendix Aviation Corp. Formerly, he was a liaison engineer for Bendix.

ROBERT L. BIGGERS, president of Fargo Division, Chrysler Motors Corp., will take the additional post of director of government and military automotive product sales. Biggers has been with Chrysler Corp. since 1930.

FRANK MAYER, founder and president of Frank Mayer Engineering Co., has been elected president of Frank Mayer International, Inc. The company has been organized to direct foreign activities in industrial management of Frank Mayer Engineering Co.

WILLIAM L. PETERSON has been made head of a new sales engineering department of White Truck Division, White Motor Co. Peterson has been director of sales promotion and advertising for White. **V. C. Speece** will manage field engineering activities for White's new sales engineering department. Formerly, he was special equipment engineer for the company.

ROBERT M. WHELAN has become assistant manager — service-sales, of American Bosch Division, American Bosch Arma Corp. He was formerly service-sales representative for American Bosch.

FRED D. FULTON is now shop manager of the Portland Shop, Consolidated Freightways, Inc. Formerly, he was foreman of the unit rebuilding and parts reconditioning department for Consolidated.

Biggers

Mayer

Peterson

Speece

Whelan

Fulton

WILFRED A. BYCHINSKY has been made chief engineer of automotive products for AC Spark Plug Division, General Motors Corp. He was formerly assistant chief engineer in charge of spark plugs for GMC.

ALVIN T. HANSON, JR., has been named manager of Chrysler Corp.'s New Process Gear Division at Syracuse, N. Y. Hanson had been manufacturing manager of the company's plant at Indianapolis since 1956.

WALTER BLAKE KING, JR., was appointed associate professor of mechanical engineering at the University of Miami. Formerly, he was supervisor of general metallurgy unit, Nuclear Division of The Martin Co.

JOSEPH W. ALLEN is now staff assistant at the Red Bank Division, Bendix Aviation Corp. He was formerly chief engineer.

ERNEST G. DAVIS is now a design-development engineer with Ford car engine and driveline department, Ford Motor Co. Formerly, he was contact engineer with Ford's Edsel Division.

ERNEST G. MURRAY has become field applications engineer-marine, with Cummins Engine Co., Inc. Prior to this, he was supervisor of installations and service — diesel, for Curtiss-Wright Corp.

WILLIAM J. SCOVRON has been made supervisor, technical service of Pennzoil Division, South Penn Oil Co. Formerly, he was a chemist for Wolf's Head Oil Refining Co., Inc.

RAYFORD R. PARKER is now manager, regional sales office of American Bosch Division, American Bosch Arma Corp. He was formerly manager of the Chicago regional sales office for American Bosch.

TERENCE R. ALCHORN was made research engineer 'A', Lockheed Missile Systems Division, Lockheed Aircraft Corp. Formerly, he was development engineer 'A' for Aerojet-General Corp.

ROGER C. BASCOM, JR., has become affiliated with the Ethyl Corp. He has recently been released from active duty with the U. S. Navy where he was a ship superintendent at the Long Beach shipyard.

JOSEPH M. SILLS is now president of Joseph M. Sills and Associates. He was formerly director of equipment for Greyhound Corp.

WESLEY S. TRINDAL is now a project engineer for the U. S. Army, Engineer Research and Development Laboratories at Fort Belvoir, Va. Prior to this, he was a product development engineer for Ford Motor Co.

GERHARD REETHOF is now supervisor, advanced and preliminary controls design of Jet Engine Department, General Electric Co. Formerly, he was chief of research for Vickers, Inc.

WILLIAM A. WINTER is now a technical staff member of Hughes Aircraft Co. Prior to this, he was senior design engineer for McCulloch Motors Corp.

HERBERT B. MILLS, JR. has become territorial representative of Arthur Fulmer Co. Formerly, he was merchandise manager for Sears, Roebuck and Co.

ALAN PINKUS is now prototype design engineer of Moog Valve Co. He was formerly an analytical engineer for Fairchild Engine and Airplane Corp.

ERNEST J. KLIMCZAK is now executive vice-president of Aermotor Mfg. Co. Previously, he was vice-president and general manager for Ahlberg Bearing Co.

JOHN P. SIMMONS is now special tester with Cadillac Motor Car Division, General Motors Corp. Formerly, he was research tester for New York Air Brake Co.

STANLEY A. KEAT has become an engineering technician on the Engineering Staff at General Motors Technical Center, General Motors Corp. He was formerly an engineering technician for Long Mfg. Division, Borg-Warner Corp.

RALPH H. DAUGSTRUP is now production manager of Cerlist Diesel, Inc. Prior to this, he was a sales engineer for Cerlist.

ROBERT J. ROBINSON has been made chief test engineer of Stanley Aviation, Inc. Formerly, he was instrumentation engineer for Lockheed Aircraft Corp.

DAVID C. HATHAWAY has become product designer (materials handling equipment), Research and Product Development Division, Yale & Towne Mfg. Co. Formerly, he was a research engineer for the same company.

JOHN W. HYDE is now assistant research coordinator of British Petroleum Co. He will be responsible for the coordination of all manufacturing reasearch throughout the B. P. group. Formerly, he was technical representative in the U. S. of the Refineries & Technical Department of B. P.

FREEDOM H. AINSWORTH has been elected president of Ainsworth Lighting, Inc., manufacturer of lighting equipment. Formerly, he was vice-president of the company.

G. D. WELTY, manager of engineering sales for Aluminum Co. of America, has retired. He has been with Alcoa since 1921 when he started as a research metallurgist. He has served as product manager for forgings, manager of aircraft industry sales, and since 1956 as manager of engineering sales. Welty has been chairman of Alcoa's technical committee since 1956.

JOSEPH F. DeMARCO is now a field service engineer with Harrison Radiator Division, General Motors Corp. He had been a ball bearing application engineer for New Departure Division, GMC.

KARL G. STARK has become fleet manager of Svenska Gulf Oil Co. A. B. in Sweden. He was formerly a research engineer for Yale & Towne Mfg. Co. in Pennsylvania.

LEWIS F. SMITH is now a compressor engineer with the Small Aircraft Engine Department, General Electric Co. Prior to this, he was a turbomachinery engineer for General Engineering Laboratory of GE.

HANS BOHUSLAV has been made manager of Piston Products, Inc. He is directing in the U. S. sales and engineering of the products of the Davy Robertson Engineering Co. of Sweden. He was formerly general manager for Miehle-Dexter Supercharger Division, Christensen Machine Co. Bohuslav has been a member of the SAE Diesel Engine Activity Committee since 1955.

WILLIAM F. PESCHEL has become Detroit district manager of Magnethermic Corp. Previously, he was engineering representative for Ohio Crankshaft Co., Tocco Division.

CARL J. GUSTAFSSON is now product engineer of Yard-Man, Inc. Prior to this, he was assistant chief engineer for Dana Corp.

THOMAS O. NEWBY has become a research engineer with Rocketdyne Division, North American Aviation, Inc. Formerly, he was a test and development engineer for Chrysler Corp.'s Missile Division.

ANTHONY C. DeMATTHEW is now a missile subsystems design engineer with AVCO Mfg. Co. He was previously associated with John Oster Mfg. Co.

JOHN C. TEW was made general manager of Falcon Industries. Previously, he had been sales manager, Automotive Mfg. Division, Thompson Products, Ltd.

WILLIAM MARTINO is now a design specialist with North American Aviation, Inc. He formerly was a project engineer for Republic Aviation Corp.

WILSON P. GREEN has been made vice-president of Gilman Engineering and Mfg. Co., a subsidiary of Parker Pen Co. He has been technical director for Parker Pen since 1956. Before joining Parker Pen, he had been associated with the Armour Research Foundation in Chicago.

CHRISTOPHER C. RACHAL, JR., has become a maintenance structural engineer with Braniff International Airways. Prior to this, he was an aircraft engineer — structures for Trans World Airlines.

WILLIAM J. KUNDRAT has become a member of the technical staff of Hughes Aircraft Co., research and development laboratories. He was formerly a project engineer with Pesco Products, Division of Borg-Warner Corp.

JAMES C. HUGHES was made senior project engineer with Lycoming Division, AVCO Mfg. Corp. Formerly, he was a research group leader with Continental Oil Co.

LEONARD E. GOOD has been named product control representative of Data Processing Division, International Business Machines Corp. in White Plains, N. Y. Good was administrative assistant to the general manager for IBM in San Jose, Calif.

WILLIAM S. FLOGAUS has been named supervisor of the technical analysis group of Sundstrand Turbo, Division of Sundstrand Machine Tool Co. Prior to this, he was a service engineer for Sundstrand Aviation Field Service Corp.

GERALD M. LARSON has been made senior product engineer (advanced truck chassis) of Ford Motor Co. Prior to this, he was a project engineer for Chrysler Corp.

JOHN W. BUCKSTEAD is now an engineer with Western Contracting Corp. Previously, he was a research engineer for Caterpillar Tractor Co.

DONALD A. WEBSTER is now in the marketing department of Oronite Chemical Co. He formerly was a sales representative.

ALBERT RAE PITTON is now a research engineer at the Rocketdyne Division, North American Aviation, Inc. Prior to this, he was a product design engineer, Engine and Foundry Division, Ford Motor Co.

JOHN A. LAUCK has been made manager of the Hydraulic Products Division, Clark Equipment Co. Formerly, he was vice-president of engineering of Pesco Products Division, Borg-Warner Corp.

JOHN F. GORDON, president of General Motors Corp., has been initiated into Tau Beta Pi, national honorary engineering society, at the University of Michigan.

A. S. KROTZ, who has retired from B. F. Goodrich Industrial Products Co. as chief design and development engineer, has been named chief engineer for Liggett Supply Co.

SIGVAL M. BERG has been named Midwest representative of Frank Mayer International, Inc., with headquarters in Detroit. Formerly, he was Detroit sales manager for Stewart-Warner Corp.

JOHN L. COLLYER, chairman of the board, B. F. Goodrich Co., will again serve as a member of the U. S. Olympic Businessmen's Committee endorsing the nation's participation in the 1960 Olympic games.

WAYNE B. JOHNSON has become director of engineering of Chicago Aerial Industries, Inc. Formerly, he was manager for Product Planning Division, Lear, Inc.

WILLIAM T. LLOYD has been named to represent the Automotive Division, Clark Equipment Co. in the southeast states. Formerly, he was a manufacturers representative for Chelsea Products, Inc.

R. J. MEINERT, district manager of Mack Trucks, Inc., was presented with a gold watch for 35 years of service to the company. The presentation was made at a dinner in his honor.

RAYMOND J. LYNCH is now an application engineer with New Departure Division, General Motors Corp. He was formerly midwest regional engineering supervisor.

ROBERT J. LAWS has become general sales manager of Baker Industrial Trucks, division of Otis Elevator Co. He joined Baker in 1955 as assistant chief engineer and in 1957 became assistant general sales manager of the company.

JOHN D. WITHROW, JR., is now a body structural engineer with Chrysler Corp.

J. P. GILLILAN is now assistant chief engineer of New Departure Division, General Motors Corp. Formerly, he was assistant to general sales manager for New Departure.

MARK GOEDECKE is now a sales engineer with New Departure Division, General Motors Corp. Prior to this, he was supervisor of engineering, Northwest Region.

PAUL W. WETZEL has been made a staff engineer with Fairbanks, Morse & Co. at Beloit, Wis. Prior to this, he was chief engineer for the same company at Three Rivers, Mich.

WILLIAM S. CHRISTENBERRY has become operations research analyst in the Overseas Research Division of Lockheed Aircraft Corp. Prior to this, he was development engineer with the Heavy Truck Chassis Department, Chrysler Corp.

R. GREY FIRTH has become sales engineer for Michigan to represent Stokes Molded Products. Firth had been with Ford Motor Co., in Purchasing.

DOUGLAS H. BETTS is now a project engineer at the mechanical laboratory of Utica Division, Curtiss-Wright Corp. Previously, he was project engineer, aerodynamics-missile department of Utica Division.

LOUIS E. DURKEE is now a sales engineer with Ensign Carburetor Co. He was formerly a sales engineer for LeRoi Division of Westinghouse Air Brake Co.

JOSEPH L. CANNELLA is now a product development engineer with Ford Motor Co. Previously, he was a production product engineer for Ford.

Obituaries

HARVEY W. HARPER . . . (A'13) . . . founder and chairman of the board of directors of Tung-Sol Electric, Inc. . . . died November 23 . . . born 1878.

CAPT. MAURICE HUDLASS . . . (M'37) . . . chief engineer of Royal Automobile Club, London . . . died October 22 . . . born 1902.

EDWARD G. HAVEN . . . (M'44) . . . manager, aircraft equipment sales of General Electric Co. . . . died October 27 . . . born 1900.

ALBERT H. PALMER . . . (A'56) . . . sales representative with Mack Trucks of Canada, Ltd. . . . died October 10 . . . born 1904.

GORDON C. RUCKS . . . (J'53) . . . laboratory engineer with Kiekhaefer Aeromarine Motors, Inc. . . . died October 4 . . . born 1926.

ARTHUR D. SCHULTZ . . . (M'57) . . . chief engineer, Stamping Division of Eaton Mfg. Co. . . . died October 6 . . . born 1915.

Planning for Progress Isn't as New as It Sounds

by

W. F. Ford

Information Coordinator

for SAE Planning for Progress Committee

WE WISH it were possible for each member of the Society to have been present and participating in all of the meetings of the Planning for Progress Committee over the three years during which it has been working on its program. This final design being proposed to the membership is one that has grown from many proposals. Numerous suggested structures were examined and analyzed. The final design is a combination and a refinement of numerous ideas contributed by hundreds of members.

In actuality, there is no single feature — to repeat, not a single feature that is new to SAE in this plan. Every idea that is proposed has seen actual use in the Society, has produced results successfully. Besides, the operations incorporated or visualized under the structure are natural to the way in which SAE members behave and operate under the philosophies, practices and traditions of SAE.

In bringing the Planning for Progress story to the membership, both the Committee and Council have striven for a happy medium in trying to explain and clarify the features of the proposal. They have tried to reveal the intentions behind the proposals, yet keep the explanations sufficiently brief so that the membership would be interested in reading the story. So, some of the discussions and plans may not have been sufficiently clarified for members with a more-than-average intensity of interest in the Society's workings.

Legalisms Not Fully Informative

The legal documents necessary to set the stage for Planning for Progress — the amendments to the Constitution being the major one — cannot give the full story. Equally as significant are the proposed Rules and Regulations for each of the three operating Boards — Engineering Activity Board, the Technical Board, and the Sections Board. True, these proposed Rules and Regulations for the Engineering Activity Board and Sections Board have no official standing yet. It is SAE practice for groups established by the Council and the Society to write their own Rules and Regulations, to govern their own methods of operation.

This is one reason why the Planning for Progress development is a somewhat complex job. It must be some while before two of the three Boards can be properly established. So, **men of the kind who would serve on these boards,** with experience in each area, were asked by the Council to visualize in advance the operations of these groups and to draft such proposed Rules and Regulations as they felt would be practiced. This is what was done. Some of the various men who helped draft these proposed Rules and Regulations seem certain to be serving on these new Boards once they are established. In any case, men of similar background, competency and stature will be filling these jobs when the new Boards *are* developed and established.

It is reasonable to assume that once the Engineering Activity Board comes into being it will adopt Rules and Regulations quite similar in philosophy and intent, if not in exact words and language, that are patterned after the already proposed rules and regulations. With that in mind, it is worthwhile highlighting some of the key features of these proposed Rules and Regulations. These highlights will point up the fact that many practices which have become traditional in the Society and precious to many of its members have been proposed under the Planning for Progress proposal.

Members Pick Their Own Leaders

For instance, it is traditional in the Society that the men picked to do the job in a given area are the ones most competent to determine whom their leaders shall be. This feature is preserved in Planning for Progress in the case of the three operating Boards.

Take the case of the Engineering Activity Board. The proposed Rules and Regulations spell out clearly the responsibility of each Activity Committee to assist the President in making appointments to the membership of the Engineering Activity Board. In other words, it shall be a function of each Activity Committee to recommend to the President men most competent from their areas to bring experience, knowledge and direction to the Engineering Activity Board. Not only is this in keeping with SAE practices; it's a practical necessity, too. Only in the Activity Committees is there the complete and thorough knowledge of capacities and capabilities of men who can assume positions of leadership in the Society's work.

Another question has to do with development of programs for National meetings under Planning for Progress. Here again, the proposed Rules and Regulations explicitly state that the program committee for any National meeting shall be composed of a hard core of men from the interested Activity Committees.

In addition, Activity Committees shall have an assigned responsibility to provide guidance to the program committees by equipping each program committee to come up with technical papers at sessions that will best satisfy the then current interest and needs of members in the Activity area concerned.

This is more than a theoretical method of operation. For quite a few years now the two National Aeronautic meetings have been operating, and very successfully, in just this way. The same type of operation has been applied with equal success to the National West Coast meeting.

ONCE IN OPERATION, THESE ACTIVITY COMMITTEES WILL IN EFFECT BE SELF-SUSTAINING GROUPS. The rules and regulations make clear that these groups will elect their own chairmen.

The chairmen, in turn, will have responsibility for the make-up of his committee. In other words, he will be charged with being sure that his committee consists of men with the technical capabilities and competency to do the job prescribed for it by the Engineering Activity Board.

Although the chairman's appointments and membership changes will be subject to the approval of the committee's EAB sponsor (one of the members of the EAB), reasonable suggestions and appointments can meet with

nothing but approval from the sponsor . . . And if the Board behaves as other SAE groups have always behaved in the past — and there is no reason to believe that it will do otherwise — the Engineering Activity Board will certainly rely almost entirely on the recommendations of the existing Activity committees in reconstituting them as committees under the Engineering Activity Board.

Committees Write Their Own Rules

Most technical committees under the SAE Technical Board have written the Rules and Regulations prescribing their method of operation. These have always been acceptable to the Technical Board so long as they were in harmony with the Technical Board's own Rules and Regulations. It is reasonable to assume that each of the Activity Committees under the new structure will likewise probably be asked to write a set of rules and regulations for its own operation. These will meet with the Engineering Activity Board's approval, provided they are in harmony with the EAB Rules and Regulations.

The Council recognizes that the groups responsible for development and distribution of technical information are the heart and core of the Society's operations. They represent the key to the Society's main reason for being. Without them, there would and could be no SAE. The Planning for Progress proposal is aimed at encouraging and enhancing the work of these Activity committees. It is designed to improve and expand the services to SAE members growing out of the work of these committees.

Future Evolution Envisioned

These are but a few of the features of the Planning for Progress proposal which already have been given careful consideration. Many others have also been anticipated. Undoubtedly there will be still others in the "future". But there is no reason to doubt that, as time goes on, the Society will move toward greater effectiveness and more productive output.

Some of the most important phases of the future potentials cannot be reduced to writing . . . or at least to legal documents. However, it is reasonable to assume that the very same men who are now leading the Society's various committees and the Society's real work will be found at the helm as SAE moves into its future. There actually is nobody else upon whom the Society could rely to carry on the key functions. And the functions remain the same, no matter what the structure under which the Society operates.

So while the men will be the same, it is hoped that under Planning for Progress they will be equipped with sharper and more effective tools for doing the job. The result will be better service to the members, on the receiving end of the service, and greater satisfactions to the men performing these services for the membership.

Volkswagen Designers and Builders Cited for '58 Elmer A.

CREATORS of the German-built Volkswagen automobile, Dr. Heinz Nordhoff, president of Volkswagenwerk, the late Dr. Ferdinand Porsche, designer of the car, and their coworkers, have been awarded the 1958 Elmer A. Sperry Award.

The presentation was made November 13, 1958, at a joint meeting of SAE and ASME, by SAE Past-President William Littlewood, vice-chairman of the Sperry Board of Award, and a vice-president of American Airlines, Inc.

The Elmer A. Sperry Award is presented annually in recognition of a distinguished engineering contribution which, through application, proved in actual service, has advanced the art of transportation whether by land, sea, or air. The award is administered by representatives of four engineering societies, the Society of Automotive Engineers, the American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers.

In addition to the medal presented to Dr. Nordhoff, a second medal was received by Ferdinand Porsche, Jr., son of Dr. Ferdinand Porsche, and a citation was accepted by Herman Bruns, a Volkswagen service representative, on behalf of his 45,000 coworkers.

In his acceptance speech, Dr. Nordhoff outlined the history of the Volkswagen which began as a political scheme of Hitler's. It then became the consuming interest of Dr. Porsche's genius, and actually a success when the British forces ordered production resumed in the 70% destroyed factory. Dr. Nordhoff said: "By one of the ironic jokes history is sometimes tempted to produce, it was the Occupation Powers who, after unconditional surrender, brought Hitler's pet dream into reality."

Tracing the growth in production from 9,000 units in 1946 to more than 550,000 per year at the present time, Dr. Nordhoff emphasized the vast improvement in efficiency. "Seven thousand workers were painfully producing 6,000 cars a year in 1948. At that time, 109 men were required to produce one

Participants in the Sperry Award presentation included, left to right, SAE Metropolitan Section Chairman S. G. Tilden, Jr.; William Littlewood, vice-president of American Airlines, Inc., who presented the award; Ferdinand Porsche, Jr., co-recipient of the award (on behalf of his late father); Dr. Heinz Nordhoff, co-recipient and president of Volkswagenwerk GmbH; and Robert B. Lea, chairman of the Sperry Board of Award.

Littlewood Wins 1958 Guggenheim Medal

WILLIAM LITTLEWOOD, right, receives the 1958 Daniel Guggenheim Medal from John H. Parkin, left, chairman of the Daniel Guggenheim Medal Board of Award. Littlewood is a past-president of SAE and vice-president — Equipment Research, American Airlines, Inc.

Littlewood has been honored for "leadership and continuous personal participation over a quarter of a century in developing the equipment and operating techniques of air transport."

The Daniel Guggenheim Medal, sponsored jointly by SAE, ASME, and Institute of the Aeronautical Sciences, is awarded annually for notable achievements in the advancement of aeronautics.

Littlewood entered the aviation industry in 1927 with Fairchild Engine and Aircraft Co., and joined American Airlines in 1930. He served the company as chief engineer, and as vice-president, Engineering, before being named vice-president — Equipment Research.

1954 SAE President Littlewood has also served SAE as vice-president representing Aircraft Engineering in 1939, and vice-president representing Air Transport Engineering in 1945.

Sperry Award

car per day. Today, this figure is 17.9," Dr. Nordhoff stated.

Nordhoff attended the Polytechnic Academy in Berlin, and upon completion of his studies, began a career as design engineer in aircraft engine construction at the Bayerische Motorenwerke in Munich. In 1930 Nordhoff was appointed head of the service organization of Adam Opel AG, Ruesselsheim, and was subsequently made technical consultant to their sales management.

After studying American production and sales methods with General Motors in the U. S., Nordhoff joined the Board of Directors of the Opel AG, and became managing director of the Opel-Werke in Brandenburg in 1942, at that time the biggest truck factory in Europe. The dismantling of this plant after the war put an end to his activities there. He was appointed president of Volkswagenwerk in Wolfsburg in 1948.

The Sperry Award, established in 1955, commemorates the life and achievements of the late Elmer Ambrose Sperry, pioneer in the development of the Gyrocompass and other navigational aids, as well as improved automobiles. He was the founder of the Sperry Gyroscope Co. The award is a gift of Dr. Sperry's daughter, Mrs. Robert B. Lea, and his son, Elmer, Jr., of the engineering profession. The Sperry Board of Award, of which Robert B. Lea is chairman, deliberates for a year before making its choice.

SAE National Meetings

- **March 16–18, 1959, National Passenger Car, Body and Materials Meeting, The Sheraton-Cadillac, Detroit, Mich.**
- **March 19–20, 1959, National Production Meeting, The Sheraton-Cadillac, Detroit, Mich.**
- **March 31–April 3, 1959, National Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display, Hotel Commodore, New York, N. Y.**
- **June 14–19, 1959, Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.**
- **August 10–13, 1959, National West Coast Meeting, Hotel Georgia, Vancouver, B. C., Can.**
- **September 14–17, 1959, National Farm, Construction, and Industrial Machinery Meeting, Production Forum, and Display, Milwaukee Auditorium, Milwaukee, Wis.**
- **October 5–10, 1959, National Aeronautic Meeting, Aircraft Manufacturing Forum and Aircraft Engineering Display, The Ambassador, Los Angeles, Calif.**
- **October 26–28, 1959, National Transportation Meeting, La Salle Hotel, Chicago, Ill.**
- **October 27–28, 1959, National Diesel Engine Meeting, La Salle Hotel, Chicago, Ill.**
- **October 28–30, 1959, National Fuels and Lubricants Meeting, La Salle Hotel, Chicago, Ill.**

Rambling . . .

THROUGH THE

World's largest

track vehicle, according to its inventor, is the Nodwell Transporter — a revolutionary development in oil rig transport equipment.

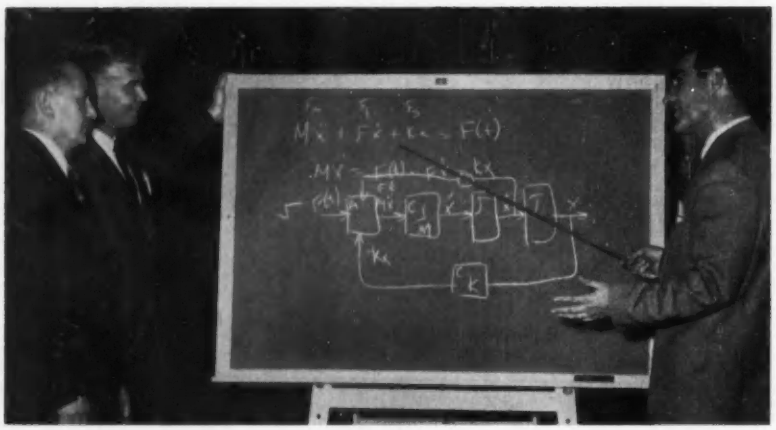
Described to SAE's **ALBERTA GROUP** in November by its co-inventor Bruce Nodwell, the machine was invented, built, and is currently being tested by Bruce Nodwell, Ltd. of Calgary, Alberta, Canada, in cooperation with Imperial and Shell Oil Companies.

The Nodwell Transporter is designed to help the oil industry maintain operations in vast Northern Muskeg areas all year around, instead of operating only a few winter months when the ground is frozen.

Distributing its weight over a track area of 28,000 sq in., the Transporter is 39 ft long and 10 ft wide. With its maximum load of 20,000 lb, and its own weight of approximately 33,000 lbs, weight on the track is less than 2 psi.

Other specifications include: two Ford 292 cu in. V8 cylinder engines; speed up to 12 mph at 3000 rpm; six-speed Allison automatic transmission; with full load, 3% of the total horsepower required for steering, with turn of 50 deg in 20 sec.

In a recent test, the unit hauled a 10½ ton load up a 60% grade on frozen ground through 6 in. of snow. Returning down the same grade, the retarders held the load without braking.



George Brown, right, chief of Bendix Products Division's computer center, explains a mathematical model and procedure for use in an electronic computer as part of his presentation at **CHICAGO SECTION'S SOUTH BEND DIVISION** meeting in November.

Onlookers are, left, T. H. Thomas, technical chairman of the meeting from Bendix Products Division's automotive engineering; and, right, P. J. Sperry, Chicago Section secretary, and divisional chief engineer, diesel engines, International Harvester Co.

Advantages found by companies in utilizing the facilities of a private research organization are:

- wide selection of talent in many fields,
- possibility of fresh approach to problems,
- relief from overloaded facilities,
- accurate knowledge of research program cost.

Such a private research organization is Armour Research Foundation, a nonprofit corporation operating on the campus of Illinois Institute of Technology — but not part of that institution. It is one of ten large comprehensive private research organizations, doing 80% work for companies having research facilities. Armour's operations were discussed in November at the **MILWAUKEE SECTION** by Dr. Richard F. Humphrys, assistant director of the Foundation.

Humphrys cited a few of the typical problems studied in the automotive field, such as lubricant research, tire noise reduction, and dash insulation improvement.

He also discussed research in the field of fiber metallurgy which indicates possible applications in brake linings and oil filters; the application of ceramic coatings on metallic surfaces for combined wear resistance, thermal insulation, and catalytic action.

Also mentioned were recent research studies on the variations of acoustic impedance of tubes with gas flow velocity and their application in muffler and intake silencer design.

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Probable specifications for the best all-around lubricant for 2-cycle engines, as a result of McCulloch Motors Corp.'s research are:

- lubricant made from solvent refined crude,
- viscosity of SAE 40
- 3–5% of "ashless" detergent,
- viscosity index between 40 and 95.

(Lowell H. Haas, chief engineer of McCulloch's Marine Products Division, at **TWIN CITY SECTION** in November.)

SECTIONS

First group, outside military and government personnel, to tour the Research Division of Curtiss-Wright Corp. in Quehanna, Pa., was **SAE'S WILLIAMSPORT GROUP.** In November, 76 engineers were shown the facilities, including the nuclear reactor, assembly and test area, computing and mathematics department, mechanical vibration laboratory, accoustics laboratory, hypersonic laboratory, advanced propulsion lab, supersonic cascade lab, materials research lab, and electronics lab, among others.

• • •

The new aerial jeep is expected to spend approximately 90% of its operating life 10–to 15 ft above the ground. Probable maximum cruising altitude will be 200 ft, certainly under 500 ft. Cruising range will be under 200 miles. (Frank E. Manrol, **BALTIMORE SECTION** in November.)

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Deputy Sheriff William K. Creson, newly appointed to this honorary post of Bexar County, Texas, is congratulated by Ben D. White, left, publicity chairman of the **SOUTH TEXAS GROUP.** Along with Creson's new authority, go the appropriate badge and hat — presented by White at the Group's November meeting.

Section Chairman Otto A. T. Colwell

Quotes from A. T. Colwell at **MID-MICHIGAN SECTION:**

"Washington could travel no faster than Caesar or Solomon."

"During the time of the Manley engine, which was cooled with wet cloths — you could tell the industry was in its infancy — the diapers showed!"

"About six people understood while 60 million laughed at the Wright prediction that the flying machine had come." "The Boeing 707 represents an improvement in time, safety and reliability — *at no cost increase* to the user."

"The Conway by-pass engine is the *first* engine developed for transport use; the outside inducted air shrouds the high velocity gas inside; result: much quieter operation, 2,000 lbs greater thrust, fuel down 15%."

"The B-70 bomber designed for Mach 3 at 80,000 ft using six J-93 General Electric engines equivalent to 1,500,000 hp, will release rocket missiles far away from the target and head for home at 2,000 mph."

"The noise of a jet engine can be reduced to zero if you don't have to fly."

(A. T. Colwell, past-president of SAE, and vice-president of Thompson Products, Inc. spoke on "Propulsion," to the Section in November.)

Designers of missile support equipment should bear in mind that there should be a minimum of assembly and testing required after factory-to-launcher-site delivery . . . and test gear should be completely mobile so that it can go to the missile and ground support equipment, instead of having to take the missile and GSE to the tester. In addition, Colonel John P. Proctor told **SOUTHERN CALIFORNIA SECTION,** there should be one reliable missile system with standarized parts, and equipment. Proctor is deputy assistant commander in chief, SAC.

Rambling . . .

Through the Sections

Display table, including SAE membership applications, pamphlets, copies of SAE Journal, and SAE Handbook, is operated at **MID-MICHIGAN SECTION** meeting by Ticket Chairman E. E. Malloy, left, and Membership Chairman H. S. Smith, right.

W. K. Creson, 1958 SAE president, visited the **INDIANA SECTION,** as well as its **FORT WAYNE DIVISION,** in October. With Indiana Section Chairman Walter Horner, left, Creson, center, appears with Ralph Kress, manager, Truck Division, LeTourneau-Westinghouse Co. Kress was main speaker of the meeting, presenting a paper on off-highway trucks.

At Fort Wayne Division, Creson spoke on "Tomorrow's Engineer." Students from Indiana Technical College and Tri-State College comprised half of the large audience.

Growth of the Illinois State police, from eight men in 1923 to 1200 men in 1958, was discussed by Coffee Speaker Francis E. Piper, training officer of Illinois State Police Department. Piper reported that 80 to 90% of the officers' time is spent policing the highways. (**CENTRAL ILLINOIS SECTION** in October.)

Construction of the Mackinac Bridge was the main topic of the October meeting, with speakers P. J. Larson, left, assistant to the vice-president; A. P. Boysen, center, district engineer; and G. R. Carter, right, erecting engineer, all from U. S. Steel Corp.'s American Bridge Division.

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Program principles at the November meeting of **CLEVELAND SECTION** were, left to right, Speaker Bart Cotter, chief engineer of GMC's Fisher Body Division who spoke on "Capturing the Stylist's Dream;" William Coleman, speaker's sponsor and assistant chassis engineer, The White Motor Co.

Cleveland Section meetings are now being held in the new Cleveland Engineering and Scientific Center, an ultra-modern, four-story building, which serves some 50 technical and scientific societies in the greater Cleveland area.

Douglas's DC-8 is an all new aircraft, in contrast to other Douglas transports which have been a series of improved versions of an older design . . . reported Gordon L. Farquhar at Northern California Section's **SOUTH BAY DIVISION** December meeting. The acceptance of the jet transports is based on economy of the jet performance, with an added bonus of higher speed.

Farquhar's paper was entitled, "The DC-8 story."

Farquhar, center, is assistant chief project engineer, DC-8 Douglas Aircraft Co. Left is John Barber of Hundly Engineering; and right, Jim Coleman, also of Douglas.

SAE Section Meetings

An emission spectrograph, used to provide early warning of wear or part failure, was discussed by Charles Jackson, supervisor of the maintenance research laboratory of Pacific Intermountain Express Co. at **NORTHERN CALIFORNIA SECTION'S** November meeting. Jackson explained that the predictions of P-I-E have been developed through routine analyses on used crankcase oil from more than 1000 over-the-highway diesel powered trucks.

Speaker Jackson, middle, is greeted by I. M. Harlow, right, technical chairman of the meeting, and V. C. Peterson, left, Section chairman.

The Army's package power reactor, now in operation at Ft. Belvoir, Va., was described at **WESTERN MICHIGAN SECTION'S** November meeting by John F. Haines, chief development engineer of Atomic Products, Alco Products, Inc.

At the speaker's table, left to right, are Elias W. Scheibe, Section vice-chairman of the Grand Rapids area; Walter C. Chaffee, Section vice-chairman of the Muskegon area; John F. Haines, speaker; and Herman F. Stapel, Section chairman.

CHICAGO and **MILWAUKEE SECTIONS** are cooperating with local members in the tri-city area of Rockford, Beloit, and Janesville, to plan additional SAE activity. The territory, rich in SAE potential, lies partially in each of the two Sections.

Pictured above are, left to right, Leo Lechtenberg, vice-chairman, Milwaukee Section; George Rea, secretary, Milwaukee Section; P. J. Sperry, secretary, Chicago Section; M. L. Hamilton, chairman, Chicago Section; Dean Thomas, chairman, Milwaukee Section; E. D. Hendrickson, treasurer, Chicago Section; and E. J. Retzinger, T. M. Robie, W. C. Arnold, from the Beloit Area. Arnold was elected chairman of the organizing group.

A get-acquainted meeting is scheduled for Monday, February 16. Notices will be mailed to members in the area.

BUFFALO

February 2 . . . Max Roensch, asst. chief engineer, Experimental Chevrolet Engineering Center. "Development of the Modern Chevrolet Test Laboratory." Wishing Well, 1190 Chili Ave., Rochester. Dinner 7:00 p.m. Meeting 8:00 p.m.

February 18 . . . Richard M. Smith, engineering advance design, Aluminum Corp. of America. "Present and Future Uses of Aluminum in Automotive Products." Hotel Sheraton, Buffalo. Dinner 7:00 p.m. Meeting 8:00 p.m.

CANADIAN

February 18 . . . SAE President-elect Leonard Raymond. "How Tomorrow's Problems Challenge Today's Research." Toronto.

CENTRAL ILLINOIS

January 26 . . . "Diesel Engine Design." Pere Marquette Hotel. Dinner 6:30 p.m. Meeting 7:45 p.m.

CHICAGO

January 26 . . . E. J. Hardig, chief engineer, Studebaker-Packard Corp. "A New Dimension in Motoring." Hotel LaSalle, South Bend, Ind. Dinner 6:45 p.m. Meeting 8:00 p.m.

February 10 . . . "Tractors, Industrial Power & Diesel Engine Activity." Knickerbocker Hotel, 163 E. Walton St., Chicago. Dinner 6:45 p.m. Meeting 8:00 p.m. Special Feature: Social Half-Hour 6:15 to 6:45 p.m.

CINCINNATI

January 26 . . . Marion Dietrich, assistant manager, Ford Motor Co. "Customers & Contradiction." Engineering Society of Cincinnati, 1349 E. McMillan St. Dinner 6:30 p.m. Meeting 8:00 p.m.

continued

SAE Section Meetings

CLEVELAND

February 9 . . . Ladies Night. Frank Reck and William Moss, Ford Times Publication Staff. "Station Wagon Living." Higbee's Auditorium, Public Square. Dinner 6:30 p.m. Meeting 7:45 p.m. Special Feature: Fashion Show by Higbee Co.

DETROIT

February 2 . . . Three simultaneous sessions. Engineering Materials Activity. V. J. Snodgrass, Republic Steel Corp.; R. V. Vandenberg, Aluminum Co. of America; M. B. Diggin, Hanson-Van Winkle-Munning Co. "We Can't Make it That Way." Truck & Bus Activity. Anthony J. Tocco and William H. Gay, Ford Motor Co. "The New Ford Truck Engines." Body Activity. Peter Kyropoulos, GMC; J. D. Ryan, Libbey-Owens-Ford Glass Co. "A Bubble Canopy." Rackham Educational Memorial. Dinner 6:30 p.m. Meeting 8:00 p.m.

February 16 . . . Junior Activity Meeting. "An Autobiography — Planning to Production." Rackham Educational Memorial, Small Auditorium. Meeting 8:00 p.m.

INDIANA

February 19 . . . Pete Ster, manager of field service, Cummins Engine Co. "The Case for Diesel." Continental Hotel, 410 N. Meridian St., Indianapolis. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Feature: Cocktail Hour 6:00 p.m.

METROPOLITON

January 29 . . . L. J. Ford, district manager, F. Leslie Jacobus, automotive engineer, Sun Oil Co. "Why Sunoco Developed Its Blending Pump." Roger Smith Hotel, Lexington Ave. & 47th St., New York City. Luncheon 12:00 Noon.

February 5 . . . Joint T & M & Diesel Dinner Meeting. Murray Simkins, executive editor, Commercial Car Journal. "Maintenance & Its Relationship to Fleet Costs in Today's Economy." Brass Rail Restaurant, Fifth Ave., between 43rd & 44th Sts., New York City. Cocktails 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m.

February 26 . . . Passenger Car & Body Activity Meeting. Robert Rodger, chief engineer, Chrysler Division, Chrysler Corp. "Unit Construction." Henry Hudson Hotel, 57th St. & Ninth Ave., New York City. Meeting 7:45 p.m.

MID-MICHIGAN

January 29 . . . R. W. Podlesak, Chevrolet Division, GMC. "Advancements of Modern Production Techniques." I.M.A. Annex, Flint. Dinner 6:30 p.m. Meeting 7:30 p.m. Special Feature: Tour of Chevrolet Plant.

MILWAUKEE

February 6 . . . John Adamson, assistant chief engineer, American Motors Corp. "Engineering History of the Rambler and the Small Car Picture Today." Milwaukee Athletic Club. Dinner 6:30 p.m. Meeting 8:00 p.m.

MOHAWK-HUDSON

February 10 . . . SAE President-elect Leonard Raymond. "How Tomorrow's Problems Challenge Today's Research."

MONTREAL

February 16 . . . SAE President-elect Leonard Raymond. "How Tomorrow's Problems Challenge Today's Research." Sheraton-Mount Royal Hotel, Montreal. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Feature: Reception 6:15 p.m.

NEW ENGLAND

February 3 . . . R. G. McMahan, staff engineer, Socony Mobil Oil Co. "Engineer Aspects of Indianapolis 500 Mile Race." M.I.T. Faculty Club, Cambridge, Mass. Dinner 6:00 p.m. Meeting 8:00 p.m. Special Feature: Father and Son Night. Movies of 500 Mile Race.

NORTHWEST

February 13 . . . J. G. Hull, Cummins Engine Co. "Light Weight Diesels — Short Hauls — Light Loads." New Yorker Cafe, 6th & Cushman Ave., Seattle. Dinner 6:30 p.m. Meeting 7:00 p.m. Special Feature: Film — NAS Car Race.

PHILADELPHIA

February 11 . . . Truck & Bus Activity Meeting. R. H. Whiteside, manager, Industrial Engine Division, Rolls Royce of Canada, Ltd. "Rolls Royce Diesel Engines." Engineers Club Auditorium, 1317 Spruce St. Cocktails 6:00 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m.

PITTSBURGH

February 24 . . . SAE President-elect Leonard Raymond. "How Tomorrow's Problems Challenge Today's Research."

SALT LAKE

February 2 . . . V. C. Vanderbilt, chief research engineer, Perfect Circle Corp. "Valve Gears & Oil Consumption." New House Hotel, Salt Lake City. Meeting 8:00 p.m.

SOUTHERN NEW ENGLAND

January 27 . . . Joseph Fluett, C.A.B. Investigator. "Civil Aeronautic Board — Jet Transport Certification." Bradley Field.

SPOKANE-INTERMOUNTAIN

February 18 . . . Ansil Page, Page & Page Co. "Page Suspensions." Caravan Inn, Spokane. Dinner 7:00 p.m. Meeting 8:00 p.m.

WASHINGTON

February 17 . . . J. E. Hart, mechanical systems, Lockheed Aircraft Corp. "Engineering Problems in Space Craft." Occidental Restaurant, Pennsylvania Avenue at 14th N.W. Dinner 7:00 p.m. Meeting 8:00 p.m.

WILLIAMSPORT

February 2 . . . Norman Gersham, chief estimator, Arwood Precision Casting Corp. "Modern Casting Techniques." Moose Hall, 33 E. 3rd St., Williamsport. Dinner 6:45 p.m. Meeting 8:00 p.m.

new faculty advisors . . .

Several SAE Student Branches and Clubs have new faculty advisors:

Fenn College — **Dwight L. Penny**

Lawrence Institute — **Kenneth Snoblin**

University of Idaho — **W. P. Barnes**

Wayne State University — **Milton G. Koenig**

Pennsylvania Military College — **Leo Blumberg**

Yale University — **L. C. Lichty**

Parks College — **Jesse B. Fox**

Georgia Tech — **R. L. Allen**

In addition, **Lawrence Hem** of the College of the City of New York, has agreed to act as advisor to the Student Branch during Professor W. Stork's leave of absence.

OKLAHOMA STATE UNIVERSITY Student Branch membership has doubled this year . . . due largely to a membership drive launched by **MID-CONTINENT SECTION'S** Joel Carson in September.

October meeting for the Student Branch featured Richard Sneed of Ethyl Corp., speaking on "New Horizons in Fuels and Engines."

Rambling through SAE Section Student Reports . . .

"It is well worth the personal time required to become able to communicate effectively," Dr. LeRoy A. Brothers, new Dean of Engineering at Drexel Institute of Technology, told the **PHILADELPHIA SECTION** at their Student Night in November. Quoting reports that "Engineers are unable to use brief and forceful English" and "We are weak in report writing and oral communication," Dr. Brothers pointed out that difficulties in understanding client problems and in describing possible solutions in understandable and convincing ways in the client's language frequently hamper the young engineer's transition from the college classroom to professional work.

Citing Operations Research as an example of a new and rapidly developing field in which men with widely different backgrounds work together to solve problems in ways not yet described in textbooks, he pointed out that engineering students have a personal responsibility to learn how to write and talk well and to work effectively in fields which will not be mentioned in their college work. "In selecting Operations Research men for the Air Force," he said," we often refused to employ men of unquestioned technical ability because they were unable to communicate easily and to work smoothly with others in solving new problems."

About 60 students and teachers from ten nearby engineering schools were the Section's guests at the annual Student Night meeting. Groups were invited from Drexel, Haverford, Lafayette, Lehigh, Pennsylvania Military College, Princeton, Swarthmore, University of Pennsylvania, and Villanova by William D. Preston, Student Activities chairman. Other features of the program were a talk on "Jets, Rockets, Guided Missiles, and Satellites" by Arthur T. Polishuk of Sun Oil and a Socony Mobil film, "The 500-Mile Challenge", describing the 1958 Indianapolis Race.

W. K. Creson Visits Parks College

World War II German missile, on display at **PARKS COLLEGE OF AERONAUTICAL TECHNOLOGY,** is inspected by 1958 SAE President Creson on his recent visit to the Student Branch. Left to right are, Creson; Jesse B. Fox, Parks College faculty advisor; Vince McDermett, Student Branch secretary; Albert A. Hazell, St. Louis Section chairman; Robert Koch, Student Branch vice-chairman; and John Wodin, Student Branch chairman.

1959 SAE Handbook Bows in with

RIDING in the wake of Christmas mail, the 1959 SAE Handbook was delivered to subscribers. The book's new size and format reflect Publication Policy Committee efforts to fit more technical material into less space.

Although the 44th edition contains an all-time high of 365 technical reports, it has 316 fewer pages than the 43rd. The insistent upward swing of technical committee work which necessitated the more uniform handling of Handbook text and illustrations is shown in Fig. 1.

Among the 27 new reports included in the 1959 Handbook are:

Air Brake Build-Up Time Instrumentation — A description of the instrumentation necessary for measuring the build-up time of air pressure at the brake chamber is given in this new SAE Recommended Practice.

Brake Lining Quality Control Test Procedure — This new technique for checking the quality of production brake linings provides the first quick-check method of its kind to be developed for industry use.

Crankcase and Transmission Dipstick Markings — Improved legibility of dipstick markings means better interpretation on the part of service personnel. The new recommended practice insures correct filling of both crankcase and transmission.

Flywheels for Industrial Engines Used for Single-Plate Spring-Loaded Clutches — Selection of flywheels for popular clutch sizes used on industrial engines is simplified by reference to this new SAE Recommended Practice.

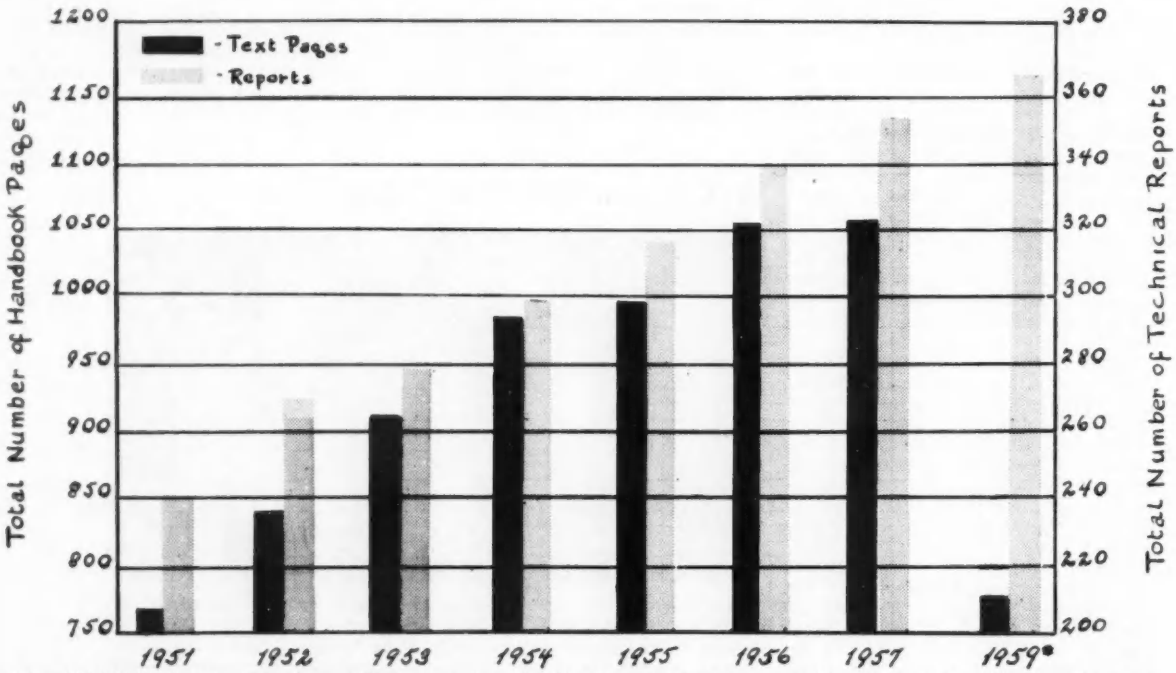
1000-RPM Power Take-Off for Farm Tractors — In addition to stepping up power output, this new standard permits interchangeability between existing 540-rpm and new 1000-rpm machinery or equipment.

Headlamp Aiming Device for Mechanically Aimable Sealed Beam Headlamp Units — Laboratory test procedures and requirements contained in this new recommended practice determine whether the device under test is capable of accurately positioning the headlamp units from their aiming pads.

12-Volt Lamp Bulbs and Sealed Units for Heavy-Duty Commercial Vehicles — As a new SAE Recommended Practice, the report lists available bulbs which are designed to give longer life under severe operating conditions.

Measurement of Vehicle Radio Interference (30 to 400 Megacycles) — For the first time, design engineers have an accurate and reproducible method of measuring random ignition system radiation from vehicles.

Turbocharger Connections — Greater flexibility in engine testing procedures is possible when this new recommended practice is followed. The report facilitates standardization of mating en-



* The 1959 SAE Handbook contains all new and revised reports produced by technical committees over an 18-month period in addition to unchanged reports from the 1957 Handbook. Thus, the 1958 edition was eliminated to enable the 1959 edition to be issued this month. Until further notice, the Society will issue the Handbook annually on January 1.

Fig. 1 — A steady increase in the technical report content of the SAE Handbook is indicated in the above graph.

New Year

gine connections and gaskets.

Among the 72 revised reports appearing in the 1959 Handbook are:

Hydraulic Brake Fluid (SAE 70R) — The new 70R3 specification for heavy-duty brake fluid has been incorporated into this report. The specification calls for a minimum boiling point of 375 F.

Truck Tractor Trailer Clearances — Overall width and swing clearances have been clarified. In addition, information pertaining to tubeless tires has been incorporated.

Motor Vehicle Seat Belt Assemblies — Minimum loop strength has been increased from 3000 to 4000 lbs.

Construction and Industrial Vehicle Test Codes — Test Code A on Reserve Tractive Ability has been brought into line with similar sections of the Agricultural Tractor Test Code.

Speedometers and Tachometers — Calibration tolerances at 10 to 30 mph has been altered.

Safety Glazing Materials — More definitions were added to this report which was up-dated to correspond with materials in the ASA Glazing Code.

Other revised reports include: Slotted and Recessed Screws, Aluminum Casting Alloys, Nonmetallic Gaskets for General Automotive Purposes (SAE 90R), Dimensional Specifications for Sealed Beam Headlamp Units, and Generator Mountings.

The 1959 SAE Handbook contains all new and revised reports produced by SAE technical committees over an 18-month period in addition to unchanged reports from the 1957 Handbook. Thus, the 1958 edition was eliminated to enable the 1959 edition to be issued this month. Until further notice, the Society will ussue the Handbook annually on January 1.

Fuel Gum Tied to Engine Intake and Performance

TO determine the effect of fuel gum content on intake system deposits and general engine performance, a series of tests on three fuels of varying ASTM gum content was coordinated by CRC, the Ordnance Corps, and the Southwest Research Institute. An analysis of test results appears in CRC 313, "Phases I, II, and III — Stationary Engine Tests Run by Southwest Research Institute — Gasoline Storage Stability Auxiliary Engine Program."

The following conclusions are given:

- No specific trend of carburetor throat deposits was established by this test fuel sequence.
- The tendency for harmful accumulation of intake manifold and port deposits increased with gum content. The Phase II average ASTM 6.5 mg per 100 ml gum content fuel appeared to be borderline for satisfactory operation of these engines.
- Increased inlet valve underhead deposits and valve sticking was observed with increasing gum content.
- The average 6.5 and 10.9 mg per 100 ml ASTM gum content fuels showed a greater volume of combustion chamber deposits than did the 2.3 mg per 100 ml fuel. The 6.5 mg per 100 ml fuel was worse in this respect than either the 2.3 or 10.9 mg per 100 ml fuel tests. The increase in gum content affected the physical nature of the deposits. (They were more friable at the 10.9 mg per 100 ml level.)
- Spark plug observations indicated a decreasing useful life with increasing gum content.
- No definite trend of ring sticking was established by this test sequence.
- Piston skirt varnish observations showed an insignificant increase in amount with increasing gum content.
- Exhaust valve malfunctioning showed no significant trend due to gum content increase.
- This test sequence shows remarkable reproducibility between engine types and models and duplicate engines.
- The selection of the test laboratory proved to be very satisfactory both from the standpoint of facilities, personnel, and climate.
- At the request of the Military and because of findings of this program, indications are that work on fuel deposit evaluation should be continued, and a summary of this work be made at a later date.

The average ASTM gum contents of the fuels used for these tests were 2.3, 6.5 and 10.9 mg per 100 ml, and the fuels were all made from the same base stock. These fuels were used in Phases I, II, and III respectively, and carry CRC designations RMF-140-52, RMF-141-52, and RMF-142-52.

Four engine types were used. Each was run in duplicate. The first was an in-line 4-cyl water-cooled engine; the second, a single cylinder air-cooled engine of the type used for stationary generator drive service; the third, a twin cylinder air-cooled engine of the type used as an auxiliary power plant for tanks; and the fourth, a single cylinder generator drive engine used as an auxiliary power plant in tanks.

CRC 313 contains 20 pp. including tables and appendixes.

To Order CRC 313 . . .
on which this article is based, see p. 6.

Stability Provisions In Aero Gas Spec Reaffirmed

STABILITY requirements in MIL-L-5572-C for aviation gasoline are reaffirmed in CRC Report 312, "Report on Aviation Gasoline Desert Storage Program." The 16-hr ASTM oxygen bomb test contained in the specification was found to insure satisfactory stability characteristics under severe storage conditions for a minimum of 30 months.

The test fuels included commercial production materials, four blends containing monomethyl aniline and several concentrations of the two specification antioxidants as well as a limited number of uninhibited blends.

Storage was in 5-gal blitz cans in every instance and in 55-gal steel drums in a few instances.

The presence of antioxidants was found to be necessary to provide the desired stability in actual storage as well as in the 16-hr specification test.

In the case of drum storage, the containers appeared to be more critical than the fuel. Container failures and excessive rust formation obviated the evaluation of fuel quality in several instances. Very few instances of cans affecting fuel quality were noted.

Color changes of various types occurred with several fuels in both cans and drums, and appeared to be related to a container variable as well as a fuel variable.

The presence of monomethyl aniline in one series of fuels caused marked and early discoloration. The rate and degree of color degradation increased with the antioxidant content of the fuel.

Gum formation was not critical in any of the inhibited fuels nor was there more than a very slight haze noted in any of them.

Storage at 110 F at two laboratories was approximately two and a half times as severe as desert storage.

CRC 312 contains 45 pp. including tables, figure, and appendix.

To Order CRC 312 . . .
on which this article is based, see p. 6.

INSPECTING EASTERN AIR LINE MAINTENANCE FACILITIES in Miami are members of Committee A-5, Aircraft Wheels, Brakes and Axles, and Committee A-12, Aircraft Landing Gear Shock and Control Mechanisms. From left to right: F. D. Swan, Goodyear Aircraft Corp.; T. A. Stanton, Civil Aeronautics Administration; D. M. Church, Bureau of Aeronautics; G. S. Bondor, Wright Air Development Center; R. F. Shank, North American Aviation; R. E. Zalesky, Eastern Air Lines; Karl Zimmerman, EAL; J. C. Terry, EAL; Stephen Gyurik, Jarry Hydraulics; K. S. Carter, Lockheed Aircraft Corp.; A. E. Drake, McDonnell Aircraft Corp.; E. L. Moyer, Bendix Products Division.

Lockheed Electra Inspected on Arrival At EAL by 2 SAE Aircraft Committees

MEMBERS of two SAE aircraft committees had the unique opportunity of inspecting the first two Lockheed Electras to be delivered to Eastern Air Lines in Miami. Through the efforts of EAL's R. C. McGuire, who is a member of both Committee A-5, Aircraft Wheels, Brakes and Axles, and Committee A-12, Aircraft Landing Gear Shock and Control Mechanisms, fellow members were able to examine the Electra at close range. In addition, EAL wheel, brake, and landing gear overhaul shops were toured.

Committee Work Related to Electra

Subsequent to the tour (held in connection with a 3½-day joint A-5 and A-12 meeting), Lockheed's K. S. Carter who is also a member of both groups, was asked to explain the relationship of SAE committee efforts and the Electra undercarriage. In reply he noted:

"Probably the closest relationship pertains to brake energy capacity requirements. Due to the very high natural drag of the Electra's propellers in the ground idle mode, the airplane can safely get by with much less braking capacity . . . than either a piston-engined transport or a jet transport."

"The need for more realistic rules for brake capacity was anticipated by A-5 in 1951. At that time, the group succeeded in convincing the Air Force specifications for the calculation of brake energy for all types of airplanes."

"The same thinking carried over into the field of civil airline transports, and the CAA approved Lockheed's rational calculations for the Electra. The result was a smaller and lighter, yet just as safe, brake than would otherwise have been forced into use under the former regulations."

"A-5 continued its discussions on brake energy calculations, and the CAB eventually amended the Civil Air Regulations accordingly. The sequency of A-5 action was: A-5 discussions; Revision of MIL specification; Further A-5 discussions, Special CAA ruling for the Electra; Further A-5 discussions; Revision to Civil Air Regulations."

The brake energy capacity on Eastern's Electra is slightly higher than that required by CAB. This is to satisfy the operational and endurance needs of EAL routes and schedules.

New Safety Device

In examining the Electras landing gears, committee members found an automatic downlock ground link which inserts a wedge into the actuating cylinder mechanism. This safety feature prevents accidental operation of the compressed strut.

The gear does not require the installation of a downlock pin (to assure that the gear will not retract while the airplane is on the ground) since the main oleo strut is angled aft, maintaining a tension on the drag strut when weight is on the gear.

Airfoil Dimensioning Related To Probe-Type Inspection Methods

A SIX-POINT positioning system and a 'composite tolerance method' of dimensioning airfoils is included in the recently revised ARP 265A on Airfoil Dimensioning. The recommended dimensioning permits simultaneous inspection of bow, twist, and contour control tolerances, and squareness-to-the-base.

In addition to defining the six-point positioning system used to establish consistent positioning for probe-type inspection, ARP 265A contains a standard dimensioning approach to the production and manufacture of airfoils.

Use of the report is expected to improve coordination between gas turbine makers and suppliers, with resultant savings in both time and money.

An eight-man subcommittee of the Aeronautical Drafting Manual Committee executed the revision under the chairmanship of C. J. Faust, Fairchild Engine Division.

Octane Number Requirements For 1956 Cars Issued by CRC

RESULTS of a survey on the octane number requirements of fourteen 1956 passenger car models representing 12 makes are given in CRC Report 309. In all, 31 laboratories submitted data on 433 cars with V-8 engines and automatic transmissions.

A summary of survey results follows:

- A larger percentage of vehicles was found to have maximum octane requirements of speeds above 2350 rpm than in the 1955 survey. Ten of the fourteen car makes tested in this survey tended to have maximum requirements of higher engine speeds with the full-boiling range reference fuels than with primary reference fuels.
- Of all cars tested, about 16% had maximum requirements at part throttle. The percentage of each car make which had maximum requirements at part-throttle with primary reference fuels varied from 4% for one car make to 29% for another car make.
- Data were available from the 1955 survey on ten of the same makes tested in the 1956 survey. A comparison of the primary reference fuel data shows an increase in requirements for seven of the ten 1956 models.
- The primary reference fuel octane number requirement distribution curves for the four areas investigated (Eastern, East Central, West Central, and Western) were quite similar.

New Plotting Procedure Used

The new plotting procedures used to obtain 1955 octane requirement distribution curves were used for the second consecutive year. (A discussion of this method is given in CRC Report 305, "A New Procedure for Plotting Octane Number Requirement Distribution Data.")

The Research method was used to find the maximum octane number requirements shown in Table 1. These figures were attained by the use of two reference fuels. Borderline knock was defined as either spark knock or surface ignition knock.

The primary fuel consisted of isooctane and normal heptane meeting ASTM specifications. It was blended in two octane number increments from 84 to 94. One octane number increment blends from 95 to 100 are also given.

Primary reference fuel blends of 101, 102, and 103 octane number were prepared by adding tetraethyllead to isooctane. The following formula was used:

$$O.N. = 100 + \frac{P.N. - 100}{3}$$

The full-boiling range reference fuel blends were prepared by cross blending three gasolines in two octane number increments from 84 to 90 and one octane number increments from 91 to 103.

Average octane number ratings of the full-boiling range reference fuel blends as determined by ten participating laboratories and fuel identification numbers are shown in Table 2.

The sensitivities of the fuels above 95 Research method octane number were somewhat greater in 1956 than in 1955.

CRC Report 309, "Octane Number Requirement Survey", contains 76 pp. including tables and graphs.

To Order CRC 309 . . . on which this article is based, see p. 6.

Table 1 — Maximum Octane-Number Requirements

Make	No. Cars Tested	Octane Number for Indicated Per Cent Satisfied			
		50%		90%	
		PR[1]	FBR[2]	PR[1]	FBR[2]
E	24	95.5	100.5	100	103+
I	32	95	96	99	99.5
L-2	32	94.5	97	97.5	101.5
N-3	32	94.5	96.5	97.5	100.5
A	23	94	96	97.5	101
D	33	93	94.5	96.5	98.5
M	30	93	95	96	98
G	34	92.5	94	97	99.5
S	29	92	93.5	96.5	99
L-3	31	92	95	96	98
O-1	33	90	91.5	94	95
H	32	88.5	90	93	95
P-A	37	88	90.5	92	94.5
N-A	31	88	89.5	91.5	95.5

1 PR = Primary Reference Fuels
2 FBR = Full-Boiling Range Reference Fuels

Table 2 — Average Octane Number Ratings and Fuel Identification Numbers

Blend No.	Composition, Volume Per Cent			Average Octane Number	
	RMFD-76-56	RMFD-75-56	RMFD-74-56	Motor	Research
1-C-56	91	9		78.5	84.0
2-C-56	76	24		79.6	86.0
3-C-56	59	41		80.7	88.0
4-C-56	39	61		81.9	90.0
5-C-56	27	73		82.5	91.0
6-C-56	15	85		83.0	92.0
7-C-56	1	99		83.6	93.0
8-C-56		93	7	84.2	94.0
9-C-56		85	15	84.8	95.0
10-C-56		77	23	85.3	96.0
11-C-56		69	31	85.9	97.0
12-C-56		59	41	86.6	98.0
13-C-56		49	51	87.3	99.0
14-C-56		38	62	88.0	100.0
15-C-56		27	73	88.7	101.0
16-C-56		15	85	89.4	102.0
17-C-56		3	97	90.1	103.0

C. S. MOTT, 50-year SAE member, was honored by the MID-MICHIGAN SECTION. Presentation of a plaque was made by E. T. Ragsdale, general manager of Buick Motor Division, GMC. Mott has been a director of GMC since 1913.

Extending congratulations are, left to right, Ragsdale; Section Chairman Everett W. Otto; Mott; and Charles A. Chayne, vice-president in charge of engineering, GMC.

6 SAE'rs Honored

SIX SAE'rs have been awarded 50-year membership certificates, having celebrated their golden anniversary of Society membership in 1958. Recipients of 50-year certificates of Membership are:

Frederick Charavay — George M. Holley — Charles S. Mott —
Frederick E. Moskovics — Julian Chase — Guy W. Vaughan.

70 members are being awarded for 35-years of membership, and 94 have completed their 25th year.

50-year member Frederick Charavay, right, receives his Certificate of Membership at DAYTON SECTION meeting from Elton S. Moyer, left, Section chairman.

JULIAN CHASE

GUY W. VAUGHAN

GEORGE M. HOLLEY

F. E. MOSKOVICS

Vendors Provide Design and Facility Evaluation

Based on secretary's report by

V. C. SOMMERS
Westinghouse Air Brake Co.

VENDORS' ENGINEERS fall generally in one of two classifications determined by the nature of the product:

1. When vendors' service consists of facility evaluation. The contractor's purchasing department should be the prime contact in this case.
2. When vendor's service consists of participation in the design concept of a product. Here the contractor's engineering department should be the prime contact.

How useful the vendors' engineers can be depends upon the category in which they fall. To illustrate the first case, let's consider dealing hypothetically with a foundry. We are purchasing from the foundry a part which, by necessity, had to be designed by us to fit some particular structure and to have the physical strength required.

We, the purchaser, have established the size, shape, and detail design without participation of vendor. Now a decision must be made as to where to purchase this part. Here the vendors' engineers might be called upon to acquaint us with their facilities as it relates to the quality of the product, control of chemistry, dimensional accuracy, ability to meet schedules, and such. This service is helpful to the contractor in the determination of an acceptable vendor, one which will give the best value for our purchasing dollar. This procedure does not necessarily require the participation of the buyer's engineering as long as the established specifications for the part are accepted. This then is a category of vendors' engineers wherein their usefulness to the customer is generally as an information service regarding their specific manufacturing facilities.

The other main category of vendors' engineers involves a different basic concept. To illustrate, consider hypothetically a bearing source. Here we are purchasing a standardized product both as to physical specifications and price structure, and in many instances the acceptable vendor might well be determined by the effectiveness of his engineering service. These engineering services definitely involve the purchaser's engineering.

In the process of creating a product, the vendor's bearing engineers might participate in the design concept by selection of proper bearing type and size, or checking and approving selected bearings even to the point of committing their company to a warranty acceptance. This is done prior to purchasing commitments as at this point we are not buying a product, but using an engineering service.

Purchasing may have suggestions as to the choice of vendor to be used for this service and many times more than one vendor should be consulted on a given engineering problem. The engineer of the purchasing contractor, however, must be the sole appraiser of the vendor's engineering service both as to what kind of service is required and what conclusions should be gleaned from such contact.

This type of vendor's service wherein participation is had in product concept can be very valuable to small organizations where engineering facilities and experiences are limited. In any event, it is a service which is to be used judicially so that there is no chance of being misled by the vendor's enthusiasm. To accomplish this, the influence of purchasing in the selection and activity of the participating vendor should be subordinate to engineering judgment.

Serving on the panel which developed the information in this article, in addition to the panel secretary were: **J. T. Morrison,** White Motor Co.; **C. A. Lindblom,** International Harvester Co.; **E. E. Eaton,** Clark Equipment Co.; **Thomas Backus,** Fuller Mfg. Co.; **V. E. Gumbleton,** Rockwell-Standard Corp.; **H. A. Williams,** Eaton Mfg. Co.; and **Merrill Egeland,** Diamond T Motor Car Co.

(This article is based on a secretary's report of a production panel entitled "Responsibility of Engineering to Purchasing." This report — along with 8 other secretaries' reports on various tractor production subjects — is available in multilith form as SP-324. See order blank on p. 6.)

Acceleration Provided by MHD Would Ease Journey to Mars

Based on paper by

ALFRED M. MAYO
Douglas Aircraft Co., Inc.

PROMISING research toward high impulse engines utilizing thermonuclear power and magnetohydrodynamic acceleration may in the future provide continuous direct thrusts high enough to provide a suitable acceleration environment. Such a system would also have the obvious advantage of reducing drastically the time spent en route on planetary flights. For example, a minimum-energy round trip to Mars, including the necessary waiting time at Mars, would require about 970 days. A round trip in which a constant 1*g* acceleration and deceleration were employed would require only 4.5 days.

Fig. 1 is a speculative rendering representing an integrated space-craft crew compartment presented to illustrate combined environmental factors and to stimulate thinking. The control center is designed to permit one man to monitor the system and the necessary controls. The computation center, laboratory, recreation and living quarters are provided in a manner designed to satisfy both physical and psychological environmental requirements for both on-duty and off-duty crew members.

Duplicate systems and ready equipment access are provided to permit the large reliability gains achievable when maintenance and part replacement can be effected during system operation.

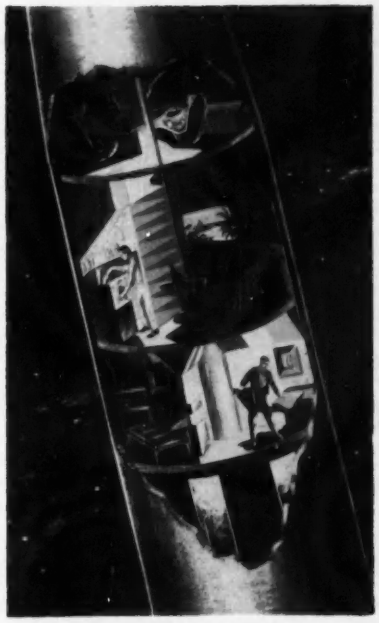


Fig. 1 — Speculative rendering representing integrated space-craft crew compartment illustrates combined environmental factors.

A constant component of acceleration of sufficient value to be compatible with the human efficiency requirements is provided in a head-to-foot direction.

To Order Paper No. 90A . . . on which this article is based, see p. 6.

Wet versus Dry Tractor Air Cleaners

Based on paper by

J. C. SIEMENS and J. A. WEBER, University of Illinois

LOW resistance to airflow may make the dry air-type air cleaner a strong competitor for the farm tractor business. Although its present capacity and size do not match the oil-bath type, higher engine horsepower and ease of maintenance are attractive results of dry-type cleaner tests at the University of Illinois.

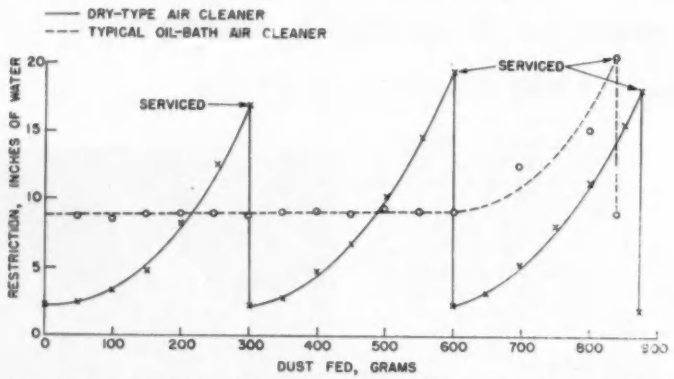
Dry filters ranging in filter area from 350 to 1850 sp in. had an initial restriction of less than 2 in. of water in tests run on 16 tractors. This was also demonstrated in laboratory tests (shown in the graph) for a filter with 1200 sp in. of paper surface.

The graph points up the capacity problem of dry filters. Both types tested had similar airflow capacity yet the dry filter lasted about one-third as long before excessive restriction was reached. However, the dry filter was serviced by tapping it out — and in laboratory tests at least, returned to its initial low restriction. AC coarse dust was used for the test.

The reverse was true in field tests for filtering chaff. Here the dry-type filter had about one-fourth the restriction of the oil bath type while handling twice as much bean fuzz. Also, cleaning the wire mesh in the oil bath filter after the test was extremely difficult.

Automobile-type dry filters will probably not be satisfactory for tractor use, due to the rugged service encountered.

To Order Paper No. 77A . . . on which this article is based, see p. 6.



Restriction buildup of oil-bath and dry-type air cleaners (laboratory test using coarse dust).

Sea Water Cools Convair Wind Tunnel

Based on paper by

W. T. MacCARTHY

Convair Division, General Dynamics Corp.

INTERCOOLERS for Convair's pressure blowdown wind tunnel are fed by sea water pumped at the rate of 3600 gpm from San Diego Bay. No cooling tower is needed because the water is returned to the Bay. There is little difference in maintenance cost between sea water and untreated water from the Colorado River. Zinc plates in the intercoolers reduce electrolytic action, and after a year of service no deterioration attributable to sea water has been found.

The wind tunnel has two test sections each 4×4 ft in cross-section, one is for transonic testing, the other for supersonic work. The perforated wall transonic section permits continuous Mach number variation through the range of 0.5 to 1.8. A flexible plate nozzle permits continuous variation of supersonic test section Mach number from 1.2 to 5.0.

Provisions are made for sidewall mounting of models as well as for sting support. In contrast to the usual arc sector or vertical strut spanning the height of the tunnel, this model support features a half-span cantilevered strut. The design was selected because of the ease with which it can be translated from one test section to another or removed entirely from the circuit. Another advantage is the decreasing strut blockage with increasing angle of attack. While not as simple in designing as the through strut for the 2½-ton model loads, it is simpler than the arc sector.

Strut action is based upon a 4-bar linkage and provides a variable center of rotation of the test model. The sting can be pitched either automatically or manually. A variable pitch rate up to 5 deg per sec is provided with an emergency rate of 20 deg per sec. By selecting the proper program, the model can be operated under continuous pitch at a preselected rate, pitch and pause, or at any desired angle and returned to starting position.

Serial Sampling Data System

The data system for this facility is one of the first serial sampling types used as the prime data system in a blowdown wind tunnel. It is designed to handle 25 analog inputs in the force measuring mode. These are generally low level signals from transducers of various types such as pressure, force, and temperature. Such inputs are amplified, commutated, converted to digital form, and stored on tape at a rate of 400 samples per sec. When handling more than 25 inputs the 25 channels are time-shared.

On completion of a run, the stored data are transmitted directly into the input of an IBM 704 computer located two miles away in the computing laboratory. Reduced data in final form are returned to the wind tunnel in no more than 15 min from the end of a blow. There data are converted from tape to cards, tabulated and plotted. Since 15 min or more are consumed in repump time, final corrected data in plotted form usually are available from a run before the next run begins.

To Order Paper No. 84B . . . on which this article is based, see p. 6.

Cost "Climate" Cuts Manufacturing Costs

Based on secretary's report by

AMOS W. ANSHUTZ

Douglas Aircraft Co.

TWO prerequisites to control of manufacturing costs by line supervision are:

1. Establishment of a "climate" of cost consciousness.
2. Participation by the line supervisor in preplanning activities.

Among the techniques used to develop a cost-conscious climate are:

1. **COMPETITION** — with published results between groups, shifts, and first line supervision.
2. **TARGET FIGURES** — for operating costs, material waste, scrap ratios, and the like.
3. **SUPERVISORY REWARDS** — a dinner "on the boss," and such.

To successfully control costs, the line supervisor must participate in preplan-

ning activities. If he plays an integral part in establishing targets and goals, he will have a sincere desire to see that they are satisfactorily accomplished.

The line supervisor himself, however, is actually the key to cost control. He must know his job as well as related work; be able to handle people so as to get the best from them; keep mentally alert, aware of his surroundings, and make prompt but sound decisions; be able to delegate, anticipate and provide for emergencies, and of most importance, be able to express himself clearly and concisely.

In addition, he should be on a continuous search for improved methods, tools, and equipment and be open to cost-saving suggestions from his workers. Only thus can a dollar be saved that might otherwise be wasted.

In addition to the panel secretary, others serving on the panel which developed the information in this article were: **Norman Neibel,** Northrop Aircraft Co.; **T. C. Pitts,** Boeing Airplane Co.; **Owen Walker,** Ryan Aeronautical Co.; **Roy A. Shettel,** Lockheed Aircraft Co.; **S. J. Sullivan,** Douglas Aircraft Co.; and **Max J. Fayrweather,** Northrop Aircraft Co.

To Order SP-325 . . . on which this article is based, see p. 6.

Curing Aeration In Cooling Systems

Based on paper by

L. A. ZWICKER
Harrison Radiator Division, General Motors Corp.

AERATION, the entrapped and entrained air in the water or coolant, causes a definite loss in truck cooling system output. It is due to poor design and it can cause not only loss of coolant, but over-heating, poor cooling, and expensive maintenance cost.

To insure freedom from aeration and water loss, several provisions can be made as follows:

- Top tank should have at least 15% of system capacity.
- Use full length top tank baffling for best water flow distribution to radiator core.
- Locate filler point in top tank remote from inlet point.
- Provide inlet and outlet fittings and hoses of a size to give minimum water pressure drop across the radiator.
- Design pump impeller for minimum internal creation of cavitation.
- Provide a thermostat valve area adequate for minimum pressure drop across the thermostat.

To Order Paper No. 99B . . . on which this article is based, see p. 6.

Radioactivity Aids RR Diesel Wear Studies

A feature of the SAE Nuclear Energy Advisory Committee

Reported by

Ray McBrian
Member, SAE Nuclear Energy Advisory Committee

RADIOACTIVE piston rings in a full-size diesel locomotive are helping western railroads to achieve fuel and maintenance economies.

This supersensitive technique of wear measurement, which has been used in smaller engines in the oil and engine manufacturer industries, is now used to dictate fuel and lubricating oil purchases as well as engine modification programs.

At the Denver & Rio Grande Western Railroad Laboratory in Denver, a 16-cyl Electromotive locomotive is running on static load test with radioactive rings in the second groove of nine pistons. The 8½-in. rings were activated by irradiation in the atomic reactors at Brookhaven National Laboratory. The rings and pistons were assembled using long-handled tools in order to keep the radiation exposure of workers at a perfectly safe level.

As soon as the "hot" engine was assembled, the test runs commenced. While the engine is running, lubricating oil from the crankcase sump is pumped through a counter. The counter, a 2-gal cylinder surrounded by 3 in. of lead and containing a sensitive scintillator crystal, can detect minute quantities of radioactive metal and can differentiate between radioactive elements. The rate of increase of radioactivity in the lubricating oil is proportional to the rate of wear of the rings. Typical example of this is the use of chrome-plated on-the-face iron piston rings, which have been made radioactive. Through this technique radioactive chrome measures the abrasion or corrosion of the face of the rings, and the radioactive iron measures the side wear through abrasion or corrosion of the piston rings. During a 6-hr run the equipment can accurately measure as little as one-third of a millionth of an inch of wear on the face of the rings.

Typical of the conclusions reached through the use of this test are:

1. Price and wear rate do not necessarily correlate for many of the fuels tested. Some so-called economy fuels perform as well as premium grade.
2. The wear caused by some low-grade economy fuels can be reduced by as much as a factor of four, through the use of improved injector design.
3. High sulfur fuels can be successfully burned. Through chemical treatment, using the electron microscope as a guide, the wear caused by 2% sulfur fuel can be cut in half.

The fruitful application of the radioactive wear test to railroad problems has just begun. An almost unlimited number of questions are waiting to be answered. Prior to the use of the radioactive technique, these answers were not available because of lack of control over test conditions or the prohibitive length of time necessary to gather data.

SAE Placement Service . . .

. . . points toward better times.

OUR last Men Available bulletin showed 7 fewer pages of applicants for jobs than a year earlier. Contrariwise, the Positions Available had 16 more pages of job openings.

Jobs up — jobless down — a salutary trend for the SAE member.

ICC Lists Ways To Improve Brakes

Based on talk by

ERNEST G. COX
Chief, Section of Motor Carrier Safety, Interstate Commerce Commission

WE of the ICC do not, of course, care to dictate the direction in which efforts toward brake improvement shall be expended. Certain phases of the matter do suggest themselves, however. These include but are not limited to improved reliability and ruggedness, reduction or elimination of the tendency to fade in prolonged applications, better balancing, or correlation of braking effort on each wheel with the load carried by what wheel, more accurate and faster control. We also wish there could be better information regarding brakes placed in the hands of the people who use and maintain them.

Regarding reliability and ruggedness, in a recent nation-wide road check conducted by the Commission, of all the vehicles placed "out of service" and allowed to be operated no farther without repairs, over 90% had deficiencies in the service braking systems as a cause.

Regarding fading, in bygone years when service brakes were of the contracting band type, we never heard of this problem. Brakes lost their effectiveness when wet, and it was largely because of the latter problem that the change to internal shoe brakes was made, since the drum itself protects the linings from road splash to a certain extent. However, the wetness problem has now been largely overcome by lining improvements. Fading is not a problem in disc brakes, because thermal expansion of the disc is principally at right angles to the direction of the force between frictional elements. While we do not pretend that either the band brake or the disc brake is an unmixed blessing, perhaps the present is not too early a date for a re-examination of the basic advantages and shortcomings of basic brake types.

All motor vehicles, so far as we are aware, have the braking effort of each axle proportioned to suit the fully loaded condition of that axle (possibly excepting motorcycles and motor-driven cycles). In private automobiles this proportion is sometimes adjusted to suit the dynamic condition of the vehicle in forward motion. We understand that this is not attempted in commercial vehicles because of the greater lengths and greater differences between loaded and empty conditions of such vehicles. However, the front axle of a truck or tractor loses little of its maximum gross weight when the truck or semitrailer is unloaded, as compared with the much greater share lost by the other axles. When the vehicle is unloaded, then, the axles other than the front are overbraked to a greater extent than the front axle. If a driver limits his brake applications to suit this condition, he under-brakes the front axle and, to a lesser extent, the vehicle or combination as a whole. It may not be practical, or even possible, to adjust the braking effort on each wheel or on each axle to suit the gross weight carried, either automatically or by adjustments made when the vehicle is loaded or unloaded. But when we consider the hundreds of motor vehicle accidents reported to us in which we are convinced that brake unbalance is at least a contributing factor, we are convinced that such adjustment is, in Hamlet's words, "a consummation devoutly to be wished."

National Safety Council tests conducted on a frozen lake show that 15

New Transmission Meets Many Load and Speed Needs

Based on paper by

K. L. MAGEE,
J. I. Case Co.

COMPONENTS of the new Case-o-matic Drive tractor transmission are arranged to provide:

1. Slow, smooth, heavy starting torques.
2. Reserve torque to apply as needed in any gear range.
3. Easy selection of direct or torque converter drive.
4. Ability to operate in higher gear with converter reserve.
5. Automatic torque adjustment.
6. Easy maneuvering of the tractor.
7. Controlled speeds through multi-range selection in selective gear transmission.
8. Reduced impact stresses in drive parts.
9. Lock-up for transport and minimum load requirements.

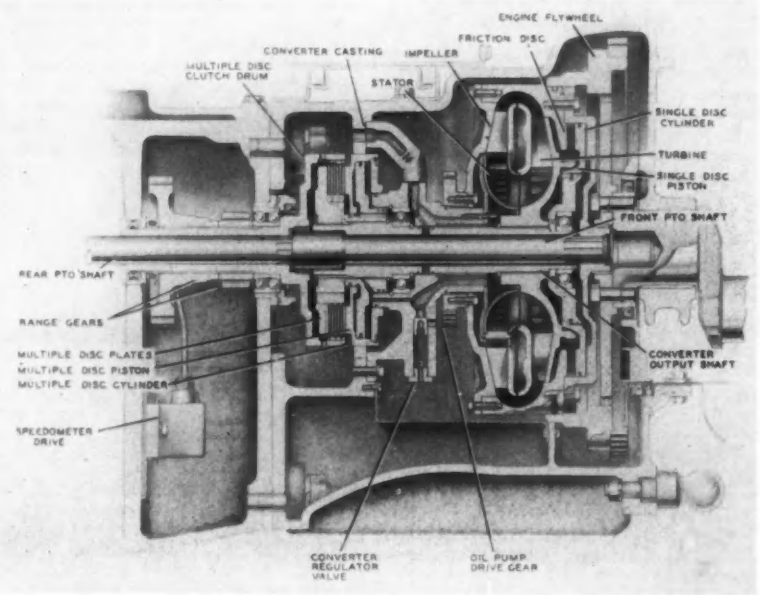
The drive consists of a standard selective gear transmission, a multiple-disc hydraulically actuated disconnect clutch, a single-stage torque converter, and a hydraulically actuated single-plate lock-up clutch on the torque converter.

Hydraulic pressures and oil flow are provided by one gear pump in the assembly. The disconnect clutch is operated by a foot pedal connected to the control spool. The lock-up clutch is actuated by a small hand lever connected to the control spool or valve.

The selective gear transmissions have eight ranges standard in the larger tractors and four ranges standard with eight ranges optional on smaller tractors.

The lock-up clutch has an interlock arrangement with the disconnect clutch so that it is automatically disengaged upon release of the disconnect clutch and cannot be engaged until after engagement of the disconnect clutch.

To Order Paper No. 81A . . . on which this article is based, see p. 6.



Sectional view through the clutch and converter sections of the Case-o-matic tractor transmission.

deg is the critical angle of jackknifing, beyond which recovery is difficult or impossible, and that this angle is reached in 1½–3 sec after brake application in which the rear axle of a two-axled tractor with single-axled semitrailer is overbraked, or locked. It appears that the situation would be considerably worse, both as to critical angle and as to angular motion of such a combination, on an icy crowned road, and still worse if a curve were involved. Other sources indicate that the average driver's reaction time is ½–¾ sec, and the brake release time may be ¾ sec or more, particularly if the brakes are in need of adjustment. Let us suppose that the tractor-semitrailer driver comes upon an unexpected patch of ice on a crowned road and has need to stop. With his brakes neither perfectly balanced nor exact in control, he may reach the critical jackknife angle in perhaps 1¼ sec. If he perceives the jackknifing action the instant it starts, takes minimum reaction time or ½ sec to release brakes, and the brakes take ¾ sec more in releasing, his predicament is obvious.

Fewer Cars Will Need Premium Fuels in 1959

Based on talk by

STUART G. JONES
Imperial Oil, Ltd.

(Reported by Burdette Trout, SAE British Columbia Section Field Editor)

PROCESSES are available for making 110-octane Grade 1 gasoline, at an indicated refinery cost of 6¢ per U. S. gal (7.2¢ per Imperial gal) more than the regular grade. Whether or not this could become available to the motorist depends on the aviation industry switching entirely to jet fuels, which require no octane number.

If high-octane gasolines were to be demanded in quantity for aircraft, then the limit available for the motorist might be 104 to 105 octane number. Some predict an eventual limit of 106 octane number, making possible a 12/1 compression ratio in car engines. But this seems unlikely in the near future because of the need to develop engines which will give satisfactory service in family car use, and because of the time required to plan, finance, and build the facilities for making this synthetic fuel in quantity.

The trend is toward lower compression ratios. 49% of the 1958 cars needed premium fuels; of the 1959 cars, only 33% will need them. The average compression ratio, weighted by anticipated production figures, is 9.5/1 for 1958 and 9.2/1 for 1959.

Chevrolet Aluminum Foundry Ready for 1960 Components

CHEVROLET and General Motors feel that aluminum has great promise for more extended use in car and truck design, according to Chevrolet's general manager, Edward N. Cole.

Talking to the SAE Detroit Section recently, he pointed out that Chevrolet's confidence in expanding aluminum use is expressed by its building its own aluminum foundry at Massena, N.Y., on the St. Lawrence Seaway. There, aluminum in molten form will be delivered to the plant from an adjacent reduction plant of Reynolds Metals Co. The Chevrolet plant covers 224,000 sq ft and will be ready for production of 1960 components.

Already, he says, Chevrolet has built experimental V-8 aluminum engines which weigh one-third less and have higher compression ratios than comparable cast-iron-and-aluminum engines. These all-aluminum powerplants, Cole says, "offer interesting possibilities in overall weight reduction, less cost for manufacturing, and better performance and economy of operation."

But Cole also stressed that many serious problems remain to be licked before aluminum engines move from the experimental to the production stage . . . and that full automobile use of the metal also awaits solution of engineering and manufacturing problems.

Neither the manufacturing possibilities nor the alloy potential of aluminum has yet been exploited, he mentioned as an example.

Currently, he said, fabricating aluminum by forging, welding, stamping or cold processing for automotive use either cannot be done or is too expensive — except for bright work. Mentioning the old question of which came first, the chicken or the egg, Cole concluded:

"Until our industry learns how to use aluminum and the other light weight metals, their use will be relatively limited. On the other hand, until we make greater use of the metals, our opportunities to experiment and learn will be kept to a minimum, and the prices probably will not drop."

Industry and Schools Comment on Ceramic Tools

Based on report by

EDWARD KIBBITT
Carborundum Co.

AMERICAN industry has enthusiastically conducted a program of experimentation and research with ceramic tools to determine their potential value as quickly and as accurately as possible. Educational institutions have also shared this enthusiasm. Here's what a number of companies and schools think about ceramic tools.

Watertown Arsenal — Considerable research and experimentation has been done on the application of ceramic tools at this government installation. General conclusions reached are that although this type of tool material is definitely not a cure-all for difficult tooling problems, the high rotational speeds obtainable with ceramic cutting tools plus the fact that they are composed of nonstrategic materials, makes them an important addition to the metal cutting field. Research and experimentation continues at Watertown Arsenal on many different aspects of the problem of applying this new material, not the least of which are investigations concerning coolants, milling cutters, and tool geometry.

Cincinnati Milling Machine Co. — Experimental work in the application of the ceramic materials to milling cutters has been in progress at this company for some time and is continuing. It is recognized that ceramic tool material has a lower modulus of rupture value than conventional tool materials, but it is also realized that earlier materials such as tungsten carbide also had this limitation. Problem of application, it is felt, is one of degree and they are optimistic about the solution of this problem recognizing that understanding and treatment of the factors involved and improved ceramic materials, will provide the solution.

R. K. LeBlond Machine Tool Co. — This company has found that in the production machining of spindles, the use of ceramic tools resulted in a reduction in machining time from 6 min to 2.8 min per piece. 715 sfpm is the speed of operation. 100% increase in production is realized.

Sundstrand Machine Tool Co. — General conclusions reached by this

Continued on page 117

Naugatuck PARACRIL OZO

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Continued from page 115

company indicate that ceramic cutting materials probably have a good future in metalworking plants where parts must be turned at high speeds and to close tolerances. Experimentation continues with emphasis being placed on the development of machine tools which will take full advantage of this type of cutting tool.

Kearney & Trecker Corp., Marquette University, University of Wisconsin — Conclusions reached as a result of experimental work and production applications are that for certain turning operations, ceramic tools are best. Emphasis is placed on the careful application of the material because of low modulus of rupture characteristics. Adequate rigidity in tool holding devices, machine tool, and work part, is stressed. Experimentation continues in the application of this material to milling cutters.

Martin Co. — Very promising results have been obtained in laboratory testing of milling cutters equipped with ceramic inserts, as well as with ceramic single point tools. Difficulty had been experienced in production applications because of the need for additional rigidity. Martin engineers believe however, that by using the best available ceramic materials, properly designed toolholders, and with provisions for adequate rigidity, a greater degree of success is just around the corner. While fairly poor tool life has been experienced on the production floor, the productivity possibilities and surface quality resulting from cutting metal with ceramic tools is outstanding.

Futurmill, Inc. — Experimental work with ceramic inserts in a milling cutter has produced good results in the machining of cast iron. Testing continues on the milling of steel.

International Harvester Co. — In experimental tests comparing performance of carbides and ceramics, this company has reported that at speeds above 800 sfpm, some of the available ceramic tool materials stand out in resistance to tool wear. Observation is made that ceramic materials available now are more consistent in quality than earlier materials.

Ohio State University — In cooperation with the Warner & Swasey Co., this university has engaged in considerable experimentation and research for the purpose of determining tool geometry for the ceramic materials. Based on their experimental work, they predict a bright future for ceramic cutting tools with the qualification that further research concerning tool geometry is necessary as well as continued development of the tool material itself.

Man-Au-Cycle Corp. — Successful experimental results have been obtained by this company in thread cutting with ceramic tools at 1590 sfpm with a 15 microinch surface finish being obtained.

Ryan Aircraft Co. — This company reports good results with ceramic tools in machining certain types of steels; poor results with other types of steels, mainly the high-temperature alloys. More success is realized with finish cuts rather than with rough, heavy, or interrupted cuts.

Borg-Warner Corp. — A recent report on the machining of SAE 1062 steel hardened to 200 Bhn indicates very successful performance with ceramic tools at 1000 sfpm. This application involves the plunge cutting of weld metal. The ceramic tool in this instance has almost four times the life of a carbide tool. An interesting observation is that the ceramic material performed better than tungsten carbide on the interrupted plunge cut.

Monarch Machine Tool Co. — Considerable study and test work at Monarch's metal turning research laboratory indicate that oxide tools can cut costs and improve production rates in turning parts to close tolerances at high speeds. Machine tools having ample horsepower, high speeds, and extreme accuracy are requirements for the efficient use of such tools.

Warner & Swasey Co. — As the result of experience gained in the application of ceramic tools, this company observes that ceramics should be con-

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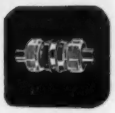
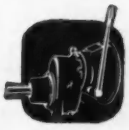

Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs


Speed Reducers

BW SEND FOR THIS HANDY BULLETIN

Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

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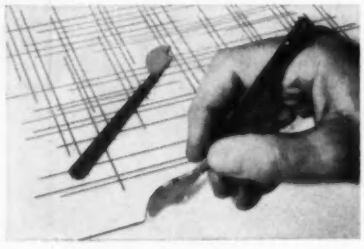
The K&E Quick Set combines the rigidity and precise adjustment of a standard bow compass, the simplicity and speed of a friction type compass, plus the finger tip control of K&E's unique design. You have to try the Quick Set to appreciate it fully. Two types are available. The N1071 fixed leg pencil compass, and the N1070 combination with interchangeable pen and pencil inserts. Both come with a box containing leads and spare needles. And with the N1070, a pen handle is provided for the pen insert which permits its use as a ruling pen. The compass can also be used as a divider by substituting one of the spare needle points for the lead in the pencil insert.



Marathon® Ruling Pens

K&E Marathon Long Line and Wide Line Ruling Pens (1092) hold an extra large ink supply – draw lines up to eight times longer than ordinary ruling pens. And because they are pre-set, line widths are always uniform, easy to match with complete accuracy. Ink flow is regular and even, lines are always sharp and clean edged.

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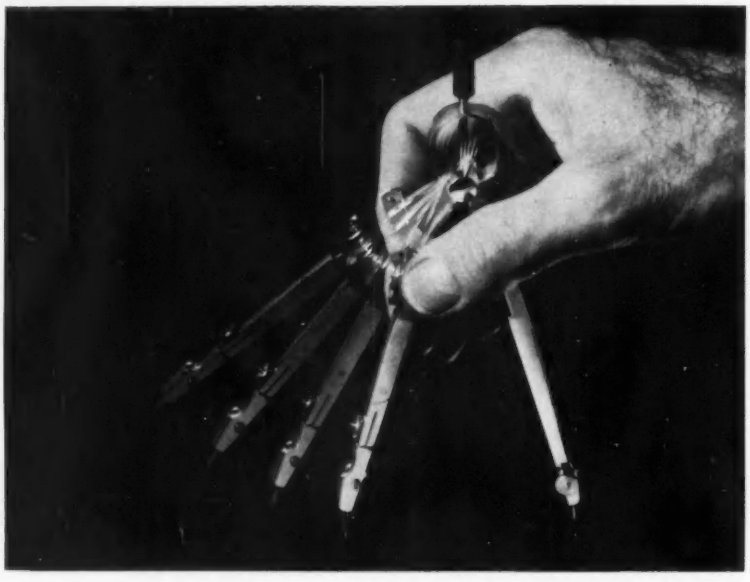
K&E Marathon Long Line Ruling Pens are available individually in line widths of .006, .009, .013, .020 inch – or in sets of three pens in line widths of .009, .013, .020 inch in a Leatherite case. Marathon *Wide Line* Ruling Pens come in line widths of .030 and .060 inch.



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1613

sidered as a replacement tool for all jobs that are now being finished turned with carbides.

Scully-Jones Co. — Several production applications of ceramic tools have been made in this plant with the observation that modern, rigid, carefully maintained machine tools are essential. Toolholders and toolholding devices must provide rigid support and proper tool geometry must be used.

Oldsmobile Division of GMC — Successful results are reported on the machining of camshafts. Oxide tools are used to finish turn different diameters on high-alloy cast iron camshafts having a hardness of 241–277 Bhn. With proper rigidity provided, oxide tools average 10 times greater life than carbides previously used.

Ford Motor Co. — Several successful applications of ceramic tools have been reported from various plants of the Ford Motor Co. Wheel brake drums, gear blanks, and automatic transmission parts are numbered among the successful applications for ceramic tools.

Chrysler Corp. — Ceramic tools have been successfully applied to several transmission parts at this company's transmission plants.

Pratt & Whitney Co., Inc. — In addition to experimental machining with ceramic tools, this company has initiated the use of ceramic materials as gage components. Cylindrical plug and ring gages, thread plug gages, anvils for electrolimit comparators, and precision gage blocks are among the various product items to which the ceramic material has been applied. It is reported that the workability of the ceramic is more favorable than other commonly used gage materials. The wringing qualities are as good or better than other materials for precision gage blocks. The stability factor is one of the best features. The coefficient of thermal expansion being closer to steel than any of the carbides, is favorable for this application.

This information is by no means complete. It represents a review of the results of only a small portion of the industrial plants, educational institutions, researchers, and experimentors engaged in the evaluation and application of ceramic tool material.

Commercial Jets Are Designed Quiet

Based on paper by

HARVEY J. NOZICK
Curtiss-Wright Corp.

JET engine noise from commercial aircraft will automatically take a drop because of new design goals. Economical and reliable operation will dictate that the specific fuel consumption and turbine inlet temperature be kept low. These two factors also act to reduce engine exhaust noise.

From the standpoint of parts life, maintenance, and reliability, it is desirable to have a minimum turbine inlet temperature. However, since fuel is 40% of direct operating costs, it is better to increase this temperature slightly by using a higher pressure ratio and therefore a much lower specific fuel consumption. Doing this will result in a slight increase of specific weight and, in the case of a lower specific thrust engine, a larger frontal area. These two disadvantages are minor for the commercial subsonic transport. In fact, an engine can grow in weight by 1% if the specific fuel consumption is decreased 1% in the case of the 1000-mile flight.

Operating at these conditions requires an engine of low specific thrust. Such an engine gives a low exhaust sound level. This has been confirmed by theory and test. A good example of this design philosophy is the turbofan engine. It has low specific thrust and fuel consumption. At subsonic operation it should compete favorably in commercial applications.

To Order Paper No. 85B . . . on which this article is based, see p. 6.

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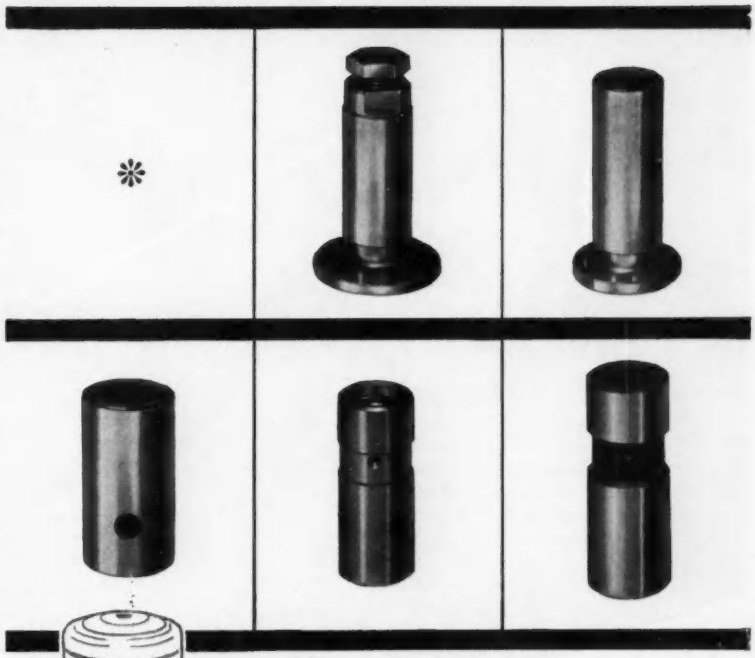

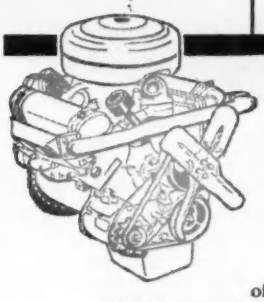

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Briefs of SAE PAPERS

continued from page 6

lating to pump-ability, anti-icing installation and suction feed capabilities.

Reliability Concepts in Design of Boeing 707 Fuel System, E. J. OSOLS, Paper No. 89B presented Sept.–Oct. 1958 10 p. System consists of seven tanks, (four mains, two reserves and center wing tank); each main tank and center wing tank is equipped with two 3-phase, 115/200 v 400 cycle a-c booster pumps; typical layout of plumbing in tanks; control valves, tank vent and jettison system; pressure fueling; icing protection by bleed air fuel heat exchangers.

Control and Measurement of Cleanliness Quality in Turbo Fuel, C. E. LOESER, D. D. LOVE, A. R. OGSTON. Paper No. 89C presented Sept.–Oct. 1958 17 p. Experience at Esso Co. with kerosene or JP-4 fuel; recommended practice with respect to airport refueling system; methods and devices in use; standardized method of sampling proposed; sampling kit and procedure used in Canada; problems to be solved by engine builders, users, and filtration equipment manufacturers.

Basic Consideration of Space Cabin Design, A. M. MAYO. Paper No. 90A presented Sept.–Oct. 1958 7 p. Effectiveness of controlled vehicle is product function of effectiveness of controller times that of machine; information display and environment contol; important environment requirements as follows: radiation; temperatures; acceleration; noise and vibration; meteoroids and space debris; internal atmosphere; food and water supply; integrated, ecological system based on biochemical regeneration presented; crew compartment.

Specific Factors in Space Cabin Design — Pt 1: Thermal and Gravitational Design Considerations with Sealed Cabins, E. G. AIKEN; Pt 2: Problems of Respiration and Decomposition with Sealed Cabins, E. B. KONECCI. Paper No. 90B presented Sept.–Oct. 1958 32 p. Pt 1: Fundamental psychophysiological considerations and tentative exploration of design concepts evolved to meet problems; Pt 2: Liveable gaseous environment; possible conventional oxygen systems for short flights and regenerative systems for long flights.

Escape Systems: Methodology to Meet Needs, A. I. BECK, G. HILDEBRAND. Paper No. 91C pesented Sept.–Oct. 1958 13 p. Design requirements must be established within concept of weapons system; physiological factors such as human tolerances to pressures, temperatures, altitudes and G forces exerted; conventional ejection seat vs enclosed escape system; concepts evolved in crash program conducted by military and industry; comparative analysis between supersonic ejection seat and minimum size capsule system.

Some Fundamental Considerations in Selection and Design of Escape Capsules, D. M. ROOT. Paper No. 91D pesented Sept.–Oct. 1958 16 p. Factors to be considered divided into survival and cost factors, i.e., escape system characteristics associated with escape survival, and effect of escape unit on weapon system; considerations with reference to altitude capability and escape capsule analysis, performed at Northrop Aircraft Inc., evaluating encapsulated seat, combination capsule, cockpit capsule, breakaway nose with and without radome.

GROUND VEHICLES

Drive Requirements of Automotive Air Conditioning Systems, C. W. MODERSON. Paper No. S 111 (Texas Sec) presented Sept. 1958, 3 p. In selection of heat transfer components on basis of element parameters, compressor may act as dynamic common denominator; study of compressor's drive characteristics in connection with clutch design shows that clutch is capable of picking up and accelerating loaded compressor whenever compressor peak running torque curve falls below slip torque curve of clutch; recommendations made.

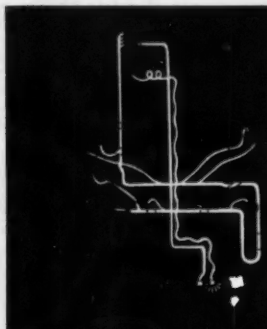
New Concept in Tractor Transmission, K. L. MAGEE. Paper No. 81A presented Sept. 1958 10 p. Transmission, developed by J. I. Case, utilizes power applied through wheels and consists of standard selective gear transmission, multiple disk hydraulically actuated disconnect clutch, single stage torque converter, and hydraulically actuated single plate lock-up clutch; hydraulic pressures and oil flow are provided by one gear pump.

MATERIALS

Processing Wrought Steel to High Strength, L. H. McCREERY. Paper No. 82B presented Sept.–Oct. 1958, 19 p. Approach taken by Chance Vought Aircraft, in processing of 4340 steel heat treated to R/C 50–53, used in structural parts, landing and arresting gear

continued

These digests are provided by Engineering Index, which abstracts and classifies material from SAE and 1200 other technical magazines, society transactions, government bulletins, research reports, and the like, throughout the world.



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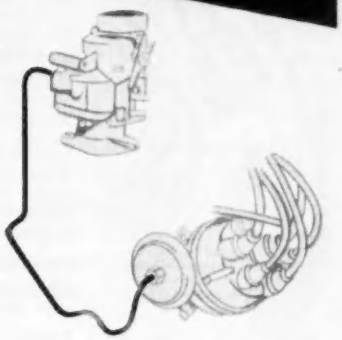

VACUUM SPARK LINE made of ZYTEL 103 adjusts spark advance to the vacuum present in the intake manifold. Operating between the carburetor and distributor, the tubing of ZYTEL resists the high temperatures beneath the hood and is unaffected by gasoline. The line is also economical to install.

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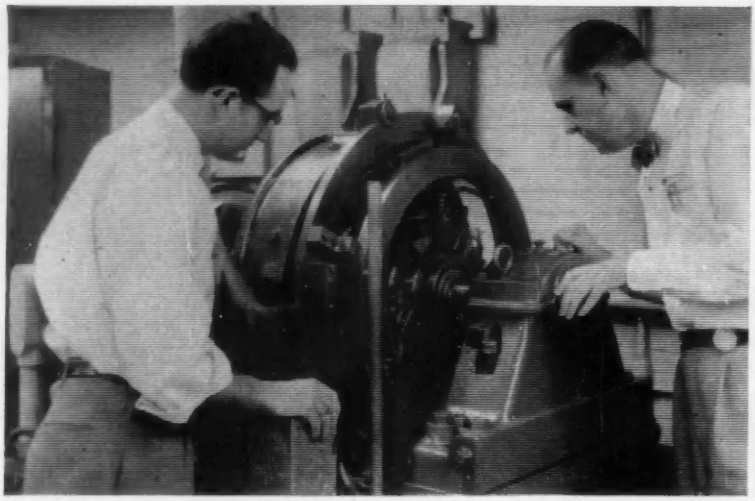

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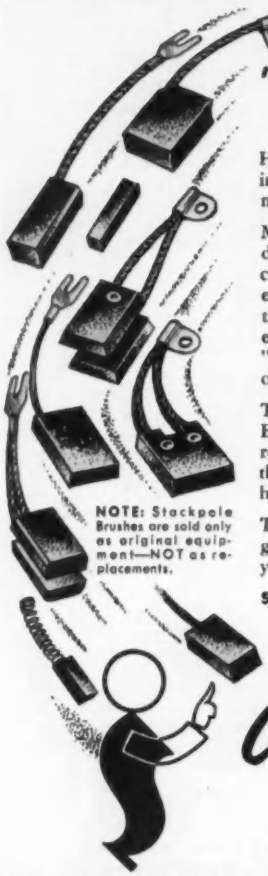

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Briefs of SAE PAPERS

continued

of aircraft fighter Crusader, Regulus II missile, etc.; steel quality requirements; heating and hot working, machining, heat treatment and finishing.

ALSO AVAILABLE

1958 SAE FARM, CONSTRUCTION, AND INDUSTRIAL MACHINERY PRODUCTION FORUM. . . . SP-324 consists of reports on 8 panels, as follows:

Production Planning for Job Shop Operations, reported by J. R. POYSER, secretary. Outlines basic principles of coordinating sales forecasts with production and inventory; of shop management; of stabilizing a job shop labor force; and related problems.

Cost Reduction — Profit Analyzation, reported by W. A. SCHLINKMANN, secretary. Discusses the parts that the industrial designer, financial man, and manufacturing engineer play in cost reduction. Training for cost reduction is also examined.

Management Planning for Profitable Survival, reported by FORREST GUNDERSON, secretary. Discusses the decision, delegation, and control phases of management as applied to new product planning.

Plant Engineering Problems, reported by J. N. JACQUES, secretary. Investigates machinery and equipment maintenance and the various considerations necessary to the intelligent buying of machines. Also tells how to sell plant engineering to management.

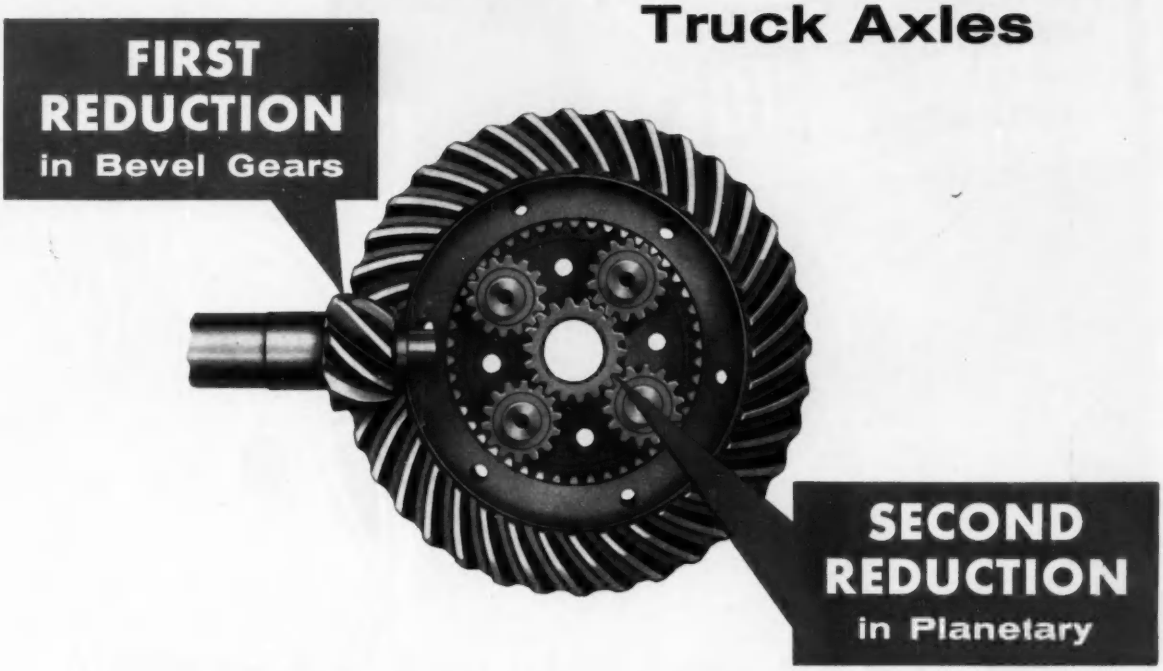
Responsibility of Engineering to Purchasing, reported by V. A. SOMMERS, secretary. Describes the part that engineering plays in the purchasing picture. Also investigates the relationship of engineering and purchasing to vendors' engineers.

Welding Methods and Process Control, reported by ROBERT MANNING, secretary. Explores the latest developments in manual and automatic welding. Also elaborates on fixtures for welding.

New Cutting Materials and Methods, reported by REINHARDT ITTNER, secretary. Describes the latest cutting tools and techniques for metal removal. Carbide tools, ceramic tools, leaded steels, and speeds and feeds are examined.

Heat Treating Techniques, reported by A. O. WOOD, secretary. A critical look at current heat treating techniques — flame and induction hardening; automation and mechanization; and the gas furnace versus the electric furnace.

A New Concept in Double Reduction Truck Axles



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Save Weight—Size for size, Eaton PDR Axles weigh less than conventional herringbone or spur gear axles, permit truckers to haul more legal payload.

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MIDLAND AIR COMPRESSORS

COST YOU LESS POWER PER CUBIC FOOT OF AIR

Trying to stretch your horsepower? Then save what you have with an efficient Midland Compressor. On the test stand or on the track, you'll see Midland Air Compressors use less power to produce more air—at any speed. Look at the valves . . . check operating temperatures . . . and you'll see why!

Don't take anyone's word for it! Run a test on a Midland Compressor today. We'll be glad to furnish samples.

MIDLAND-ROSS CORPORATION

OWOSSO DIVISION,
OWOSSO, MICHIGAN

AIR MIDLAND BRAKES

ONE OF THE 400 LARGEST AMERICAN CORPORATIONS

New Members Qualified

These applicants qualified for admission to the Society between November 10, 1958 and December 10, 1958. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Alberta Group

Norman Herbert Parson (A).

Atlanta Section

Edward P. Leibold (M), Lewis William Quoss, Jr. (J), Gale Stanley Stitt (J).

Canadian Section

Lloyd Brian Bender (J), Eric Donald Broger (J), Lawrence A. Hendren (A), Edwin J. Nugent (M), Donald G. Sippel (J).

Central Illinois Section

Wayne E. Roberts (J).

Chicago Section

Arthur R. Blank (J), Kenneth E. Clausen (J), Lewis S. Kron (M), Charles W. Kyte (A), William A. Magie, III (A), William W. Sabin (M), Duane Richard Sjaardema (J), Joseph P. Steger (J), James L. Thompson, Jr. (J), Robert Martin Voitik (J).

Cincinnati Section

Lawrence J. Jamison (A), Howard J. Revelson (A), Laurence R. Woodward (J).

Cleveland Section

Fred A. Alger (M), Raymond Holanda (J), Donald W. Liechty (J), Ralph Miller (J), Robert James Myotte (J), James F. Ulrich (M).

Colorado Group

John Welsh Robinson (J).

Dayton Section

L. James Boude (J), Capt. Arthur Madison Casbeer (J), Frank H. Fisher (J), Alfred J. Fonzi (M), Wayne F. Korn (J), James C. Rine, Jr. (J).

Detroit Section

Anthony L. Barclae (A), Carl L. Betteridge (M), John A. Bott (A), John D. Calhoun, Jr. (J), James Dean Campbell (J), Joseph C. Cervas, Jr. (M), William Paul Christiansen (J), Paul A. Clark (J), Clifford Joseph Collins, Jr. (J), Thomas Edward Duffy (J), Arnold Andrew Eusebio (J), Clifford R. Fales (J), Richard E. Gallette (J), Thomas W. Gillie (J), Sebastian Joseph Giuffrida (J), George Richard Glass (J), John T. Grady (J), Robert L. Graves (J), Charles Gordon Gunderson (J), Richard John Hames (J), Donald E. Hart (M), Inge Christian Holm (J), Harold M. Jacklin, Jr. (M), Henry R. Jaeckel (M), Donald H.

continued

10 to 100 times the wear resistance of other dry bearings

Comparative Thrust Washer† Performance

Type of Material	Mean Testing Time	Reason for Stopping
DU Composite	1000 hrs.	Completed 1000 hrs.
T.F.E. in porous Bronze	213 hrs.	.005" wear
Graphite & Lead Bronze	158 hrs.	.010" wear
T.F.E. + 25% Graphite	134 hrs.	.005" wear
Oil impregnated Bronze	105 hrs.	.010" wear
Phenolic resin + MoS_2	73 hrs.	.005" wear
T.F.E. + 25% Glass fibre	48 hrs.	.005" wear
MoS_2 Treated Steel	26 hrs.	Seizure
Graphite (bearing grade)	24 hrs.	.005" wear
Porous Bronze + MoS_2	17 hrs.	.005" wear
Asbestos + resin + MoS_2	0.8 hrs.	.005" wear
Nylon	0.3 hrs.	.010" wear

†*Thrust Washers used for comparative tests as most indicative of true relationship of values, since clearances do not enter into their performance.*

*TEFLON, *Du Pont Trademark*
FLUON, *I.C.I. Trademark*

Compare performance and you will agree that DU—the patented steel-backed porous-bronze bearing with T.F.E.* fluorocarbon resin-lead—offers an entirely new conception of dry bearing service.

Consider its high compressive strength with no cold flow (51,000 psi.)—its extremely low friction with no slip-stick characteristics—its equally efficient performance at temperatures from −328° F to +536° F—its resistance to solvents, detergents, abrasive atmospheres—and you will find the answer to many difficult bearing problems where conventional lubrication is impractical or undesirable.

Ask your bearing manufacturer or write for engineering brochure to

SPECIAL PRODUCTS DEPT.
United States Gasket Co.
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

AUTOMATED!
ALUMINUM INGOT HEAT TREATING

Here's how one of the nation's leading producers of aluminum has met their increased production demands . . . with a high volume Holcroft in-line automated furnace.

Their problem was to heat 30,000 pounds of aluminum ingots per hour for rolling into sheet. To provide the efficiency required to meet this production schedule, Holcroft designed a continuous furnace incorporating automatic discharge and transfer of the hot 6,000 pound ingots onto the mill roll table (as shown). The design did not stop here, however . . . 24 hour a day, 7 day a week operation was not required. So, to utilize off-peak production periods, when the break-down mill wasn't operating, the furnace was designed for *double* duty . . . as a batch-type unit for homogenizing special alloy ingots. And you can't top that for efficiency!

Yes, the swing to aluminum will call for more automation, plus more and larger continuous heat treat equipment. And for this, *call Holcroft* . . . where many years experience in aluminum heat treating are combined with unmatched "know how" in the field of automated heat treat equipment. Let this combination automate your aluminum heat treating . . . call Holcroft today!

HOLCROFT & COMPANY

6545 EPWORTH BOULEVARD
DETROIT 10, MICHIGAN
PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

CHICAGO, ILL. • CLEVELAND, OHIO • HARTFORD, CONN. • HOUSTON, TEXAS • PHILA., PA.
CANADA: Walker Metal Products, Ltd., Windsor, Ontario.

New Members Qualified

Continued

Kerska (J), Kenneth C. Kraemer (M), James Louis Mason (J), Raymond A. McCarroll (M), Richard Dee McKenna (J), Arman Mooradian (A), W. C. Northrup (M), Juozas Orentas (J), Andrew Paredes (J), Theodore E. Peterson (J), Robert T. Quail (J), Richard Jerome Socin (J), Charles J. Stofko (M), Clifford A. Trathen (A), Kenneth B. Valentine (M), John L. Van Becelaere (J), Arthur D. Walker (M), Lauren H. Wells (A), Ernest M. Werner (A).

Hawaii Section

John L. Nugent (A), Roy Sherman Tucker (A).

Indiana Section

James Hanen Garrett (J), Larry W. Noggle (J).

Kansas City Section

Keith H. Birkett (M), Joseph W. French (M), Robert N. Jackson (M).

Metropolitan Section

H. D. Brown (M), George Edward Capek (J), Robert D'Agostino (J), Henry Anthony Marzullo, Jr. (J), Oscar Bernhardt Schier, II (M), Richard P. Schroeder (M), Kenneth William Sims (A), James Alexander Spencer (J).

Mid-Michigan Section

Lloyd A. Brasseur (J), John B. Giacoletti (J), Roger L. Hoyt (J), Richard J. Rademacher (J), Jacob G. Stoner (J).

Milwaukee Section

Richard James Bayley (M), James T. Boone (M), Norman Vern Denney (A), Louis E. Dondero (M), Robert B. Ewart (J), Enno A. Gerbitz (J), Burzoe K. Ghandhi (J), E. H. Harms (A), Herbert G. Heimann (M), James McLaren (A).

Mohawk-Hudson Section

Arthur Frank Campbell, Jr. (J).

Montreal Section

Edward A. Kersulis (J), Garry T. Lacy (M), James A. Lundy (M), Richard Lorn MacLaren (J), H. Roy Runciman (A).

New England Section

Robert L. Benford (M), Gareth A. Keith (J), Howard E. Pendergast (M), George Schultz (A).

continued

XXX

This is the thirtieth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Evaluating the Machinability of Alloy and Carbon Steels

To produce a useful part, most steel has to be shaped by one or more of the metal forming methods. One of these is metal cutting or machining, which changes the shape, size, or finish of a workpiece.

Alloy or carbon steels are often received from the mill in the raw form of bars, forgings, or castings. The steel is placed in a suitable machine, such as a lathe, multiple-spindle automatic bar machine, drill press, milling machine, or one of a number of other types. Metal is then removed from the steel stock until it has acquired the desired shape. This is accomplished by causing motion to take place in the sharp-edged cutting tool, or the piece of steel, while they are held in contact with each other. Cutting tools, such as drills, tool bits, milling cutters, and the like, are made from highly-alloyed steel (tool steel), cast alloys, sintered carbide, or even ceramic material.

During machining, the metal is removed in the form of chips which may be of any length, from the short, well-broken type, to the long, stringy and continuous variety—depending upon the nature of the steel, the shape or geometry of the cutting tool, the speed and feed at which the cutting is done, and the coolant or cutting fluid applied.

"Machinability" of steel refers primarily to the ease with which it can be reduced to its final shape. It is measured by the speed and feed at which it can be cut, the quality of the surface finish produced, the length of time the tools will last, and the kind of chip formed in cutting. In a "free-machining" grade of steel, for example, high speeds and feeds can be used, tools will stand up well, surface finish will be good, and chips well broken.

Machinability is evaluated in the shop by the number of pieces having a satisfactory finish, within the required dimensional tolerances, that can be produced in a shift, or a day, with adequate tool life.

It can be appreciated that the study of the cutting of metals involves a large number of variables. These may be grouped in the following way:

1. Steel Analysis (Process, composition, microstructure, and mechanical properties)
2. Machine Tool (Condition, tool accessories, range of cutting speeds and feeds with ample power, etc.)
3. Type of Machining Process (Turning, milling, forming, broaching, etc.)
4. Cutting Condition (Speeds, feeds, and depth of cut)
5. Cutting Tool (Composition, treatment, hardness, size, shape, grinding and surface finish)
6. Cutting Fluid (Characteristics, application, and volume)

From this number of complex factors, laboratory tests and investigations have developed experimental data by using single variables, such as steel analysis, tool analysis, tool shapes, and cutting fluids. This information has proved to be a useful guide when combined with industrial experience; for no test method by itself has yet been developed that will include all the characteristics of a specific single or multiple-machining operation.

Bethlehem metallurgical engineers have had long and varied experience and knowledge on the machinability of alloy and carbon steels. They will gladly give you any help you may require in connection with machining problems.

In addition to manufacturing all AISI standard alloy steels, Bethlehem produces other than standard analysis steels, and the full range of carbon grades. Call your nearest Bethlehem sales office for information.

If you would like reprints of this series of advertisements, please write to us, addressing your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa. The subjects in this series are now available in a handy 44-page booklet, and we shall be glad to send you a free copy.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Lowers original equipment costs!
Lowers selling price of truck!
Lowers fuel, maintenance and replacement costs per truck mile!

Lipe

DIRECT PRESSURE CLUTCH

Vital component in today's most economical system of power transmission, the Lipe DPB Heavy-Duty Clutch costs less at the start . . . materially reduces the competitive selling price of the vehicle . . . and affords substantial savings in over-all truck-operating costs per mile.

Other elements of the power-train contribute to these savings, but the Lipe DPB Heavy-Duty Clutch absorbs the greatest shocks and fiercest friction, dissipates the most heat, and by its simplicity, direct drive, easy adjustment and replacement-exchange, keeps the vehicle rolling with less cost for fuel, brake relining, oil replenishment and repair. Its worth in highway safety and preventative brake maintenance alone places it far in advance of costlier and more complicated drive components.

Advanced thermodynamic design and positive air circulation add up to a heavy-duty clutch of uncomplicated design with few moving parts. In short, it's a clutch with a low maintenance cost that matches both its low first cost and greatly lower truck-mile costs of operation.

● Lipe DPB clutches now available in 12", 13", 14", 15" single and two plate models. Write for engineering data sheets on the sizes which interest you.

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N. Y.

MANUFACTURERS OF AUTOMOTIVE CLUTCHES AND MACHINE TOOLS

New Members Qualified

Continued

Northern California Section

Richard Louis Burkhalter (J), Edgar F. Cronin (J), James A. English (J), Lewis M. Gibbs (J), Thomas Allan Hunter (J), H. Harry Mueggenburg (J), Orville D. Page (A).

Northwest Section

John William Bartlett (J), Gerald Grant Johnson (J), Norman L. Nesbit (J), Gerald Edward Price (J).

Oregon Section

Victor V. Cox (M).

Philadelphia Section

Julius Uradnisheck, Jr. (M).

Pittsburgh Section

Harry J. Dell (J), Ronald L. McCafferty (J), Eugene John Pasquinelli (J), Joseph Gaber Scott (J), Benjamin S. Yaffe (M).

St. Louis Section

Richard Charles Bueler (J), John Gregory Hessburg (J), Kenneth Randolph Mills (J), Harry John Sauer, Jr. (J), Charles Albert Towne (J), George Allen Wolsfelt (J).

Salt Lake City Group

Melvin Clarke Taggart (J).

San Diego Section

Alan C. Baker (J), Donald Francis Barton (J), James K. Marechal, Jr. (A).

South Texas Group

Norton B. Hargis (M).

Southern California Section

Bruce M. Bohi (J), Richard A. Dudek (J), Walter Eugene Edelman, Jr. (J), Irvin M. Frankman (M), Frederic H. Graff (J), Thomas Edson Hickoff, Jr. (J), John A. Kenworthy (J), Wallace Christian Kolberg (J), Roger L. Mackenstadt (J), Paul Lloyd Mohnkern (J), Leo A. Tairov (M), Filiberto Vargas (J), George R. Williams (J).

Southern New England Section

Alan Dubrow (J), Bruce Joseph Dunbar (J), Langdon G. Johnson (M).

Syracuse Section

Vito Vincent Gassi (J).

Texas Section

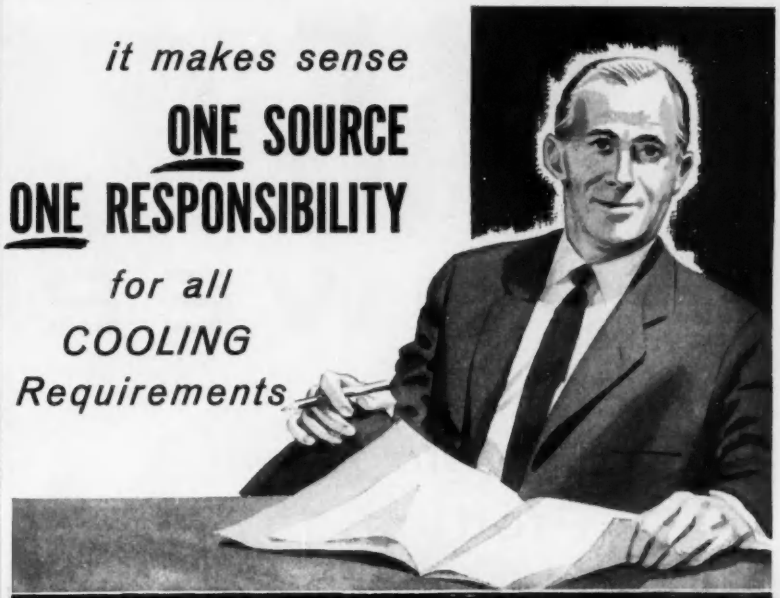
John Marvin Metcalf (J), Harold K. Wilson (J).

continued

it makes sense

ONE SOURCE
ONE RESPONSIBILITY

for all
COOLING
Requirements



Young / *Heat Transfer Specialists*

ONE source, one responsibility for all cooling requirements is the sensible approach to solving heat transfer problems. By using one reliable source, you automatically solve problems of service, and there is never a question of responsibility for performance. Young's wide range of products and over 30 years experience in designing, engineering and manufacturing radiators, oil coolers and heat exchangers qualifies them as the most logical source for all your cooling needs. Let us show you what undivided responsibility can mean in the way of economy, quality control and efficiency of performance. Write, wire or call without obligation.

YOUNG RADIATOR COMPANY
RACINE, WISCONSIN

Acquaint yourself with Young's wide range of products

MAIL COUPON TODAY FOR FREE CATALOGS...

Check the catalogs and literature you would like to receive. Mail coupon to Young Radiator Co., Racine, Wisconsin, Dept. 119-A.

- ☐ Cat. No. 1652 — Young Supercharger Air Intercoolers
- ☐ Cat. No. 1356 — Young Jacket Water Coolers
- ☐ Cat. No. 557 — Horizontal Core Air Cooled Heat Exchangers
- ☐ Cat. No. 1258 and No. 1156 — Shell and Tube Heat Exchangers
- ☐ Cat. No. 1054A — Young Torque Converter Coolers
- ☐ Cat. No. 3558 — Type 'OH' Unit Oil Coolers

Name .....

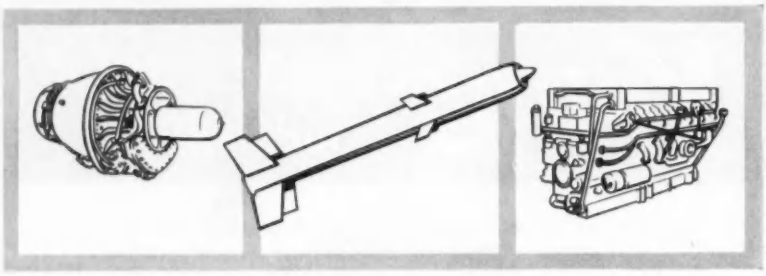
Company .....

Address .....

City ..... Zone ..... State .....

CAE POWER

- Research
- Development
- Production



TURBINE RAMJET RECIPROCATING

● Continental Aviation & Engineering Corp. is exceptionally well qualified, both by experience and by facilities, for work on the weapons systems of tomorrow. Our background embraces not only a half-century of internal combustion engine experience, but also years of pioneering in gas turbine engine development, and a full decade of work in the field of solid fuels for ramjet propulsion of missiles and target drones . . . Continental is staffed and equipped for a wide range of assignments, military and commercial. The Detroit Division Research and Development Department is supported by our modern-to-the-minute Component Testing Laboratory complete with environmental facilities located at Toledo. The Toledo Production Division now producing various turbine engines in volume is capable of supporting diversified programs . . . The CAE record of achievement is one of which many a larger company might be proud. Inquiries are invited from those having propulsion problems, on the ground, on the water, in the air.

☆ ☆ ☆

CONTINENTAL AVIATION & ENGINEERING CORPORATION

12700 KERCHEVAL AVENUE, DETROIT 15, MICHIGAN

SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

New Members Qualified

Continued

Washington Section

Donald Eugene Tempesco (J).

Williamsport Section

S. Allan Westman (M).

Outside Section Territory

Edward J. Buekers (J), Donald James Garcia (J), Joseph Francis Gunne (A), B. Thomas Horace (J), E. Eugene McCoy (J), John Beam Olinger, Jr. (J), Bert C. Ovesen (M).

Foreign

Giovanni Bonmartini (M), Italy; Gaudenzio Bono (M), Italy; Rowland Slater Guy (M), England; K. Fritz Kugel (M), West-Germany; Antonio Mora (M), Spain; Dr. Karl-Heinz Muhr (M), West Germany; C. Ramaswami (J), S. India.

Applications Received

The applications for membership received between November 10, 1958 and December 10, 1958 are listed below.

Atlanta Section

James J. Nally

Baltimore Section

Ed Hoyt Parkison

British Columbia Section

Lewis W. MacQueen, David George Rennie

Buffalo Section

John Dollinger, Edward E. Foster, John J. Hart, Robert S. Wind

Canadian Section

C. H. Bottoms, Andrew G. Douglas, Alan S. Duff, Robert Ivan Hillmer, Edward J. Koenka, James George Perrin, Terrence B. Seawright, Derek James Wheeler

Central Illinois Section

Willis Dale Dillon, Arthur R. Jensen, Robert A. Jones, Joseph Dean Sappington

Chicago Section

Ervin F. Brinkman, Ralph James Erisman, Frederick H. Harrison, C.

continued

where big jobs keep moving!

Firestone **Perma-Tite** *Rims*

New Firestone Earthmover Rims are 100% fusion-welded, 100% airtight for maximum tire life.

The exclusive Perma-Tite rim design insures a permanent air seal for absolute tire protection! Special fusion-welding helps make Perma-Tite rims the strongest you've ever used. Firestone Steel Products Company's balanced weld design gives equal penetration throughout the section. Stress tests assure rim reinforcement at high strain points. The truest rolling rim you can own—it gives 100% tire support, reduces sidewall flexing and lets tire run cooler for longer service. Specify Firestone Perma-Tite rims as original equipment; buy them as replacements. They're available for tubeless or tubed off-the-highway tires.

SPECIAL PROTECTION against rust and corrosion for longer rim life, better tire performance.

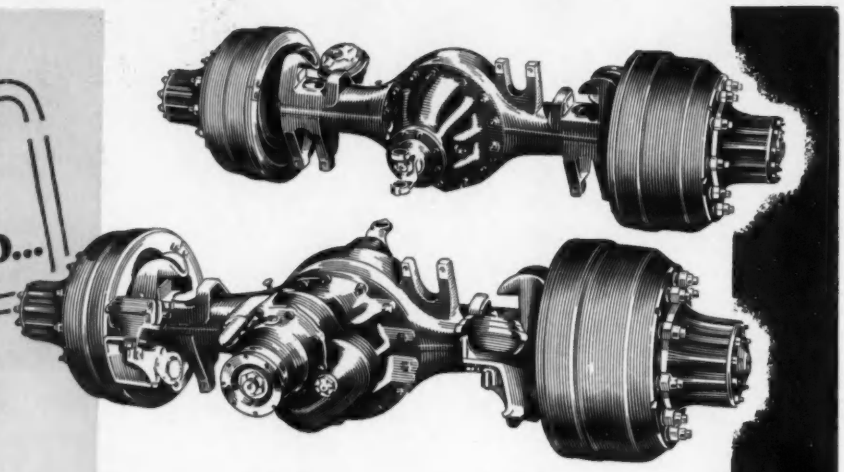
INTERCHANGEABLE in complete units or by components with all Earthmover rims and parts.

COMPLETE AIR SEAL insures retention of air at recommended pressures, delivers longer tire service.

FIRESTONE STEEL PRODUCTS CO. *Akron 1, Ohio*

INTEGRITY. ACCURACY. QUALITY. DEPENDABILITY

PROVED AND PREFERRED...



For three years..

Timken-Detroit® Lightweight Driving Tandems—First Choice With Big Over-the-Highway Operators!

These superior features make the difference:

Lighter than any comparable tandem on the market . . . but a real heavyweight when it comes to service. Besides increased payloads you get long, trouble-free service and lower operating costs. Time-proved, Timken-Detroit Lightweight tandem features include:

Driver Controlled Inter-Axle Differential. Torque is divided equally between axles, yet wheels of one axle can turn faster or slower than wheels of other axle. This means both axles are always doing equal amounts of work. Driving parts and tires last longer.

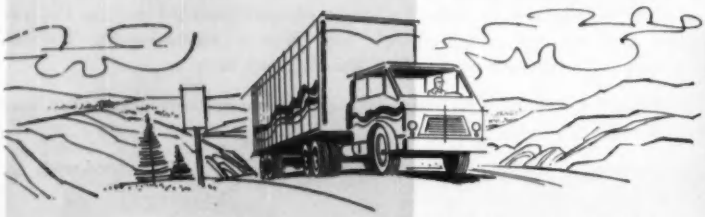
"In-Line" Propeller Shaft Drive. With straight-through drive, bearing and gear life is greatly increased because universal joint working angles are materially reduced.

Torsion Flow Axle Shafts. More splines, plus greater root and body diameter, add extra strength.

Hot Forged Rectangular-Shaped Axle Housings. Rectangular shape, combined with full strength corner sections, provides the greatest strength with minimum weight and size. Welded on bowl cover prevents leakage.

Hypoid Gears. Larger pinions and greater tooth contact give 30% more torque capacity, top efficiency and long life . . . plus lower maintenance costs.

Unmatched Parts Interchangeability. Most of the wearing parts—gears, bearings, shafts, differentials, brakes—are interchangeable with parts from Timken-Detroit standard single axles. Parts are readily available and less expensive.



WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSES AND TRAILERS

TIMKEN Detroit AXLES

ROCKWELL-STANDARD CORPORATION
TRANSMISSION AND AXLE DIVISION
DETROIT 32, MICHIGAN

The Accepted Standard

©1958, R-S Corp.

Products of **ROCKWELL-STANDARD** Corporation

Applications Received

Continued

Elmer Johnson, Hubert Raymond Kerwin, William J. Kremer, Emanuel M. Leon, William L. Ronney

Cincinnati Section

John D. Bourke

Cleveland Section

Roy P. Allen, Arthur R. Breed, Russell R. Lussier, Alan D. Thomas

Colorado Group

Galen O. Giersdorf, B. C. Pittman

Detroit Section

Ira James Barker, John William Beardmore, Donald J. Clark, Glenn F. Doyle, Denzil L. Hammond, Roger Sandberg Hanson, John L. Harned, Robert L. Kingsbury, William Frederick Marshall, Roger E. Maugh, Chester K. Murphy, Elliott L. Myers, William Nagy, Norman A. Norris, John Pankow, Donald William Seal, John M. Slessor, Ronald Joseph Smith, Remi A. Van Steenkiste, Elmer F. Zink

Hawaii Section

Robert H. Gutcher

Indiana Section

Erville J. Bitler, Harry L. Boese, Anthony Francis Brodnicki, Paul A. Davis, John G. Mehagan, Don V. Myers, Glen R. Renner, Kenneth W. Young

Metropolitan Section

Richard F. Barrett, Stanley Jay Bruce, James F. Harris, Stanley M. Jackson, Jr., William Lawrence Kennedy, Walter Robert Looker, Marco Lucatorto, Alfred Monacelli, Harold R. Munhall, John George Reichel, Carl A. Swenson

Mid-Michigan Section

Howard Daniel Brown, Maurice J. Christianson, James D. Karn, Carl Albert Koerner, Robert W. Podlesak, Clio F. A. Sanborn, Charles Raymond Wendt

Milwaukee Section

Robert F. Blomquist, Keith F. Kummer, Andre Anthony Ruisbroek

Montreal Section

William Edward Armstrong, Gordon Thomas Keys, Alex F. Morrison

New England Section

Hector D. Petri

Northern California Section

Charles W. Besso, William Eugene Elder, Jack F. Hecht, Sr., Floyd L. King, Clinton A. Phalen

Northwest Section

Frederic Kemble Brunton

Oregon Section

Roy Wells

Philadelphia Section

David Seeley Blew, III, Clifford E. Clarke, Theodore F. Jackson, John A. Keller, Lester J. Stradling, Jr.

Pittsburgh Section

Elbert S. Howarth

St. Louis Section

Donald J. Terry

Southern California Section

George W. Cornelius, William Lee Hamilton, Edward Kazmarek, Donald F. Pepper, James Thomas Reilly

Southern New England Section

Charles Wakefield Bishop, Joseph F. Chlupsa, Richard E. Evans

Texas Section

Robert K. Kolster

Twin City Section

C. O. Groth, Albin E. Larson, Joseph M. Ziabicki

Washington Section

W. Richard Kolk, James D. Reeves, Jr.

Western Michigan Section

Ernest Bader, Jr.

Wichita Section

William Charles Benson

Williamsport Group

Julius J. DeCarolis, G. Warren Kline

Outside Section Territory

Robert D. Charles, Ramsay R. Jackson, James Arnold Kiely, Lyle Fletcher Loukes, Charles A. McKinnon, Carl F. Mickey, Leslie Earl Roby, L. W. Steege

Foreign

Douglas Jose Arcuri, Brazil; Otto Deligdisch, France; James R. V. De Livera, Ceylon; Dr. Naeim Abdou Henein, Egypt; Jose Bento Hucke, Brazil; Patrick L. W. Kelly, Australia; Gosta Kullberg, Sweden; Arie Matus, Israel; Graham F. J. Murray, England; Brian Grenville Stacey, England; Thomas W. Tillson, England; Clifford Hillery Travis, Saudi Arabia

PROMPTEST MAN ON WHEELS

He's the punctual ELECTRIC man. Call him for the quickest answers and the fastest follow-through on wheels.

Whether you're putting wheels on a new product or improving an old one, you want production schedules and prices while you're planning. That's why ELECTRIC sales engineers work with you on the job.

Call one in on your next problem. See what a seasoned man, backed by the capacities and capabilities of an automated operation and years of agricultural and industrial experience, can do for you.

Call or write today for whatever you want in a disc or spoke-type wheel (steel or rubber tired), rim, hub, axle or component part.

"What we sell is service"

ELECTRIC WHEEL CO.

Write to Department 11A,
1120 N. 28th St., Quincy, Illinois, BAldwin 2-5320

DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

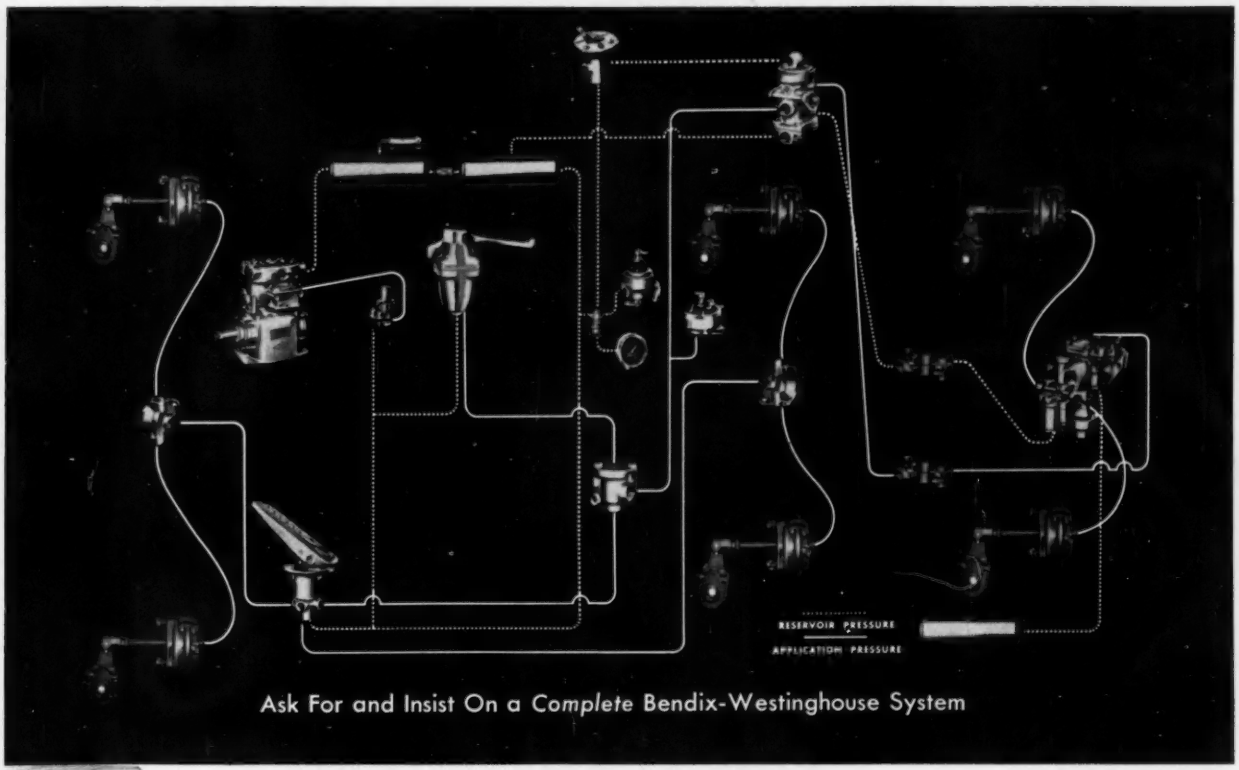
THE COMPLETE CHAIN IS
1

WHAT COUNTS!

Yes . . . the *complete* chain . . . made of safety-forged, matched links . . . with the built-in dependability and performance that only an experienced chain maker can deliver. It's the same with air brakes. You *could* buy a link here and a link there. But you get by far the most efficient, most reliable performance when you specify a *complete* Bendix-Westinghouse Air Brake System. It, too, is engineered as a complete "chain" in which every part and every component is *system-engineered* to do its specific job with peak efficiency. And for that reason you not only get top performance with Bendix-Westinghouse—but get it over a longer period of time and at less cost than is possible any other way.

Best proof of this is that more trucks and buses are equipped with Bendix-Westinghouse Air Brakes than with all other makes combined. These thousands of truck and bus operators who make up the Bendix-Westinghouse "family" long ago proved an important fact to their own satisfaction—that it pays to let us assume full systems-engineering responsibility for air brake performance, dependability, and long, economical service life.

Another exclusive advantage you get with Bendix-Westinghouse is our Repair Exchange Service—most outstanding in the entire industry. It permits exchange of any worn unit for a factory-reconditioned replacement unit, rebuilt to the latest design, at nominal cost and with new-equipment warranty.

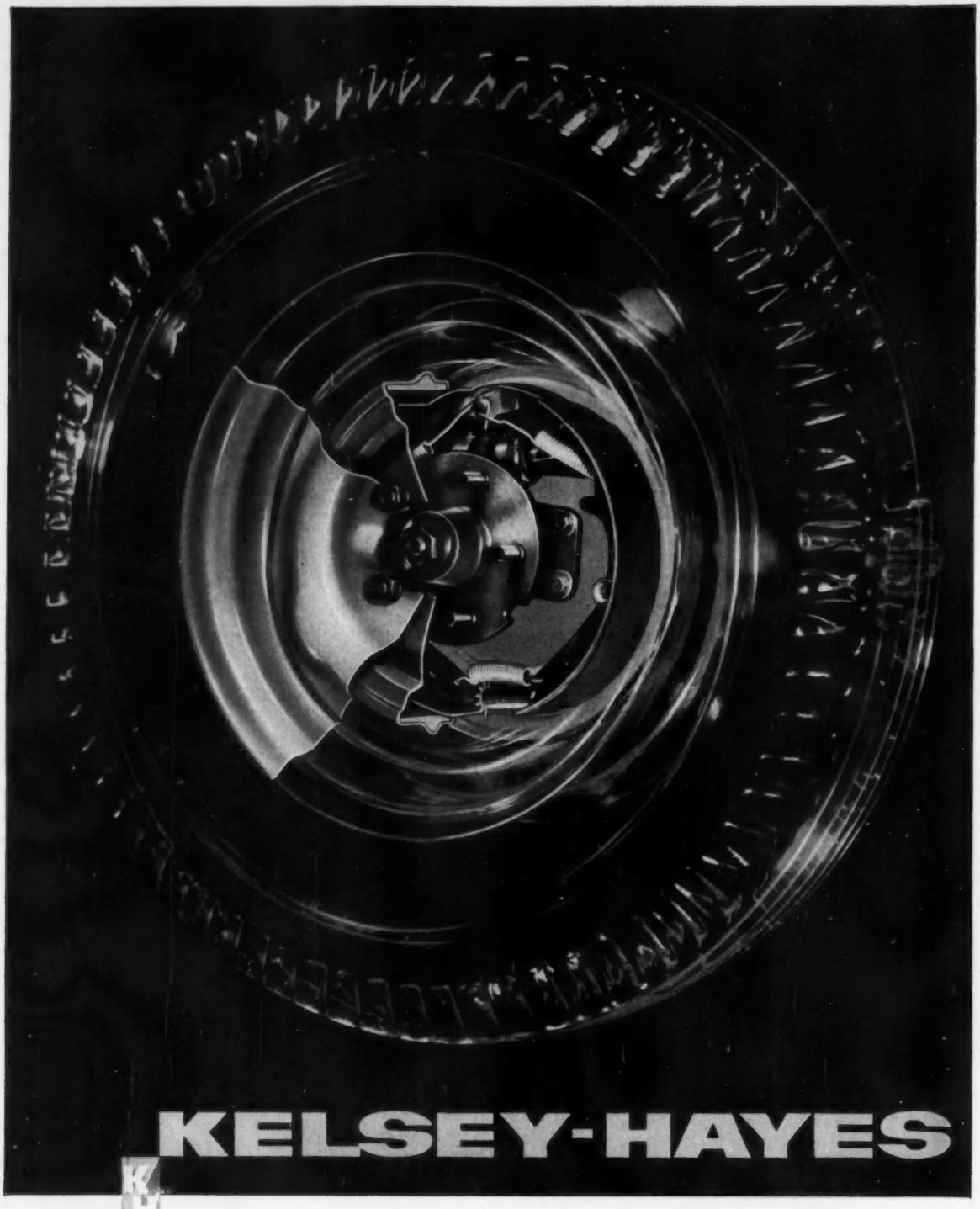


Ask For and Insist On a *Complete* Bendix-Westinghouse System

Bendix-Westinghouse

AUTOMOTIVE AIR BRAKE COMPANY

General offices and factory—Elyria, Ohio. Branches—Berkeley, Calif. and Oklahoma City, Okla.



KELSEY-HAYES COMPANY
Gen'l Offices: Detroit 32, Mich.
Automotive, Aviation and Agricultural Parts • Hand Tools for Industry and Home

18 PLANTS: Detroit and Jackson, Mich.; Los Angeles; McKeesport, Pa.; Springfield, Ohio (Speco Division); New Hartford, N. Y. (Metals Division); Utica, N.Y. (Utica Drop Forge & Tool Division); Davenport, Iowa (French and Hecht Division); Philadelphia (Heintz Division); Clark, N. J. (New Jersey Division); Windsor, Ontario, Canada.

Reflected in this modern motor car wheel, hub-and-drum, and brake assembly are the precision and excellence of quality which have earned for Kelsey-Hayes a respected name among suppliers to the automotive industry since 1908. Products representative of the specialized skills and facilities of Kelsey-Hayes in the manufacture of fine automotive parts and components include: *wheels, brakes, hubs and drums, power brakes, transmission bands and other chassis parts.*

There is no substitute for Stainless steel
in automobiles

No other material is as bright, strong and resistant to rust and wear as Stainless Steel. It gives every car the clean, exciting beauty that sells in the showroom and re-sells on the used car lot. Look for *Stainless Steel* on your new automobile.

Specify McLouth high quality sheet and strip Stainless Steel. McLouth Steel Corporation, Detroit 17, Michigan.

McLOUTH STAINLESS STEEL

Now you can get standard sizes in C/R End Face Seals!

Chicago Rawhide now announces the availability of a complete new line of Standard End Face Seals to meet the widest possible range of sealing requirements. For sizes or conditions beyond the range of Standard End Face Seals, C/R engineers will continue to cooperate with you on special designs. Their experience in sealing applications is unmatched — your assurance of getting the correct seal for the job.

Write for your free copy of this new C/R Bulletin →

Bulletin EF-100 includes complete envelope space data on C/R Standard End Face Seals and mating rings to help you select the correct size for your equipment design:

- Size range table in two series — long and short — from ¾ to 4 inch shaft diameter.
- Size range table on mating rings.
- Typical seal installations for internal and external pressure.
- Special instructions on how to order.

C/R
STANDARD
END FACE SEALS
maximum sealing efficiency in minimum space
• ¾ to 4 inch shaft sizes
• pressures to 500 psi.
• temperatures to 550° F.
• peripheral speeds to 15,000 FPM.
• external or internal pressures
2 complete series . . . long and short . . . pre-engineered to meet the widest possible range of sealing requirements. Standard mating rings also available.
Special End Face Seals . .
For special sizes and extreme conditions other than those for which the C/R standard end face seal was designed, C/R will continue to develop new seals or recommend existing designs. C/R's years of sealing experience assure you of the right seal for your job.
CHICAGO RAWHIDE MANUFACTURING COMPANY
1301 Elston Avenue
Chicago 22, Illinois

C/R

CHICAGO RAWHIDE

CHICAGO RAWHIDE MANUFACTURING COMPANY
1243 ELSTON AVENUE • CHICAGO 22, ILLINOIS
Offices in 55 principal cities. See your telephone book.
In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario.
Export Sales: Geon International Corp., Great Neck, New York
C/R PRODUCTS: C/R Shaft and End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-Metallic Gears

Bill Adcock, Supt. of Motor Maintenance
RINGSBY TRUCK LINES, Inc., says:

"Our 'RINGSBY ROCKET' Averages 10,000 miles before we change oil and DIESELPAK"*

Makes 2 non-stop runs Los Angeles to Chicago—with superior oil filtration—at a COST LESS THAN 4¢ PER 100 MILES

Only LUBER-FINER DIESELPAK, with its *exclusive* specially processed media, removes oil contaminants *effectively*—FAR LONGER THAN ANY SUBSTITUTE PACK.

DIESELPAK—designed expressly for use with H.D. detergent compounded oil—removes not only injurious suspended solids, but also colloidal impurities (often more destructive) *without affecting the additives.*

Thus LUBER-FINER DIESELPAK

1. COSTS LESS than ineffective substitutes because it gives MORE MILES of *effective filtration.*
2. Also ADDS THOUSANDS OF MILES to ENGINE AND OIL LIFE because its exclusive engineered protection CLEANS OIL FASTER AND KEEPS IT CLEAN LONGER.

STANDARD AND OPTIONAL EQUIPMENT—On leading Diesel Trucks, Tractors and Stationary Engines.

*A typical statement of many users, engineers, and original equipment manufacturers on file.

VISUAL PROOF why DIESELPAK is The Standard of the Industry

Positive end seals prevent the oil from by-passing. The oil is filtered through the patented media of the DIESELPAK which removes colloidal particles and other contaminants without adversely affecting the additives.

The oil then passes through several layers of protective fibrous material which is scientifically engineered to positively prevent media from migrating into the engine.

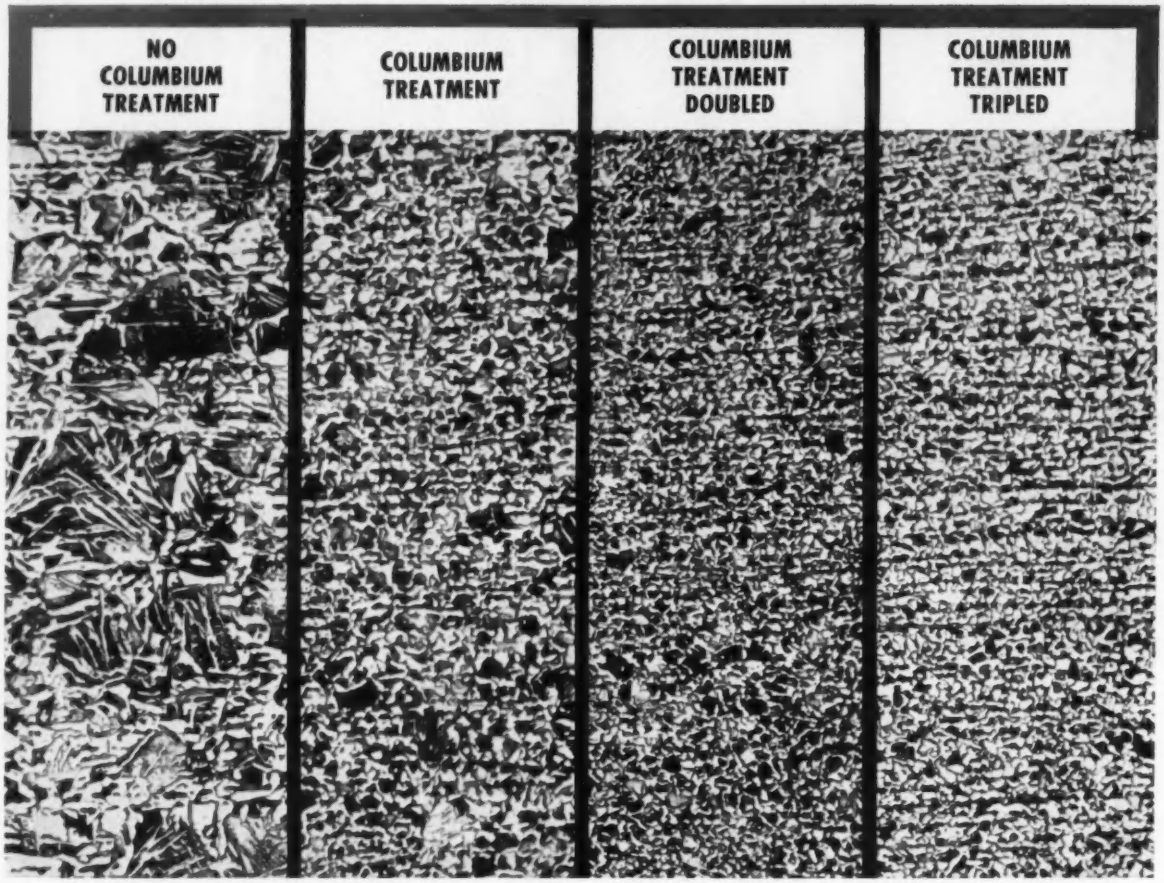
World renowned engineered protection is enjoyed only by the users of the genuine LUBER-FINER "DIESELPAK."

Luber finer

WRITE FOR INFORMATION—how to get MORE MILES of effective lubrication at LESS COST. Dept. F-3.

LUBER-FINER, INC.
2514 South Grand Avenue, Los Angeles 7, California

HOW GREAT LAKES



Composite of photomicrographs made from the same heat of mild carbon steel shows the effect of varying columbium treatments on the grain structure of the steel.

The Great Lakes Family of High-Strength Steels

N-A-X FINEGRAIN STEEL

Lets you design superior performance, longer life and less weight into your product. Many diversified applications.

N-A-X HIGH-TENSILE STEEL

Offers all the characteristic features of N-A-X Finegrain, plus greatly enhanced resistance to atmospheric corrosion.

GLX W

A series of fine grained, mild carbon steels. They have unusually high strength, toughness and weldability.

N-A-X N-A-XTRA STEELS

Quenched and tempered steels of excellent weldability and toughness, with yield strengths from 75,000 - 110,000 psi.

N-A-X HIGH MANGANESE STEELS

N-A-X High Manganese and High Manganese Special Killed. These steels give yield strengths up to 50,000 psi.

STEEL CORPORATION'S NEW GLX-W STEELS GIVE ... HIGH STRENGTH TOUGHNESS REDUCED COSTS

Key to the success of Great Lakes' new GLX-W Series of steels is the fine grained internal structure produced by treatment with columbium. This grain refinement also contributes to ductility. And in addition, the GLX-W Series' low carbon and manganese content assures excellent weldability with freedom from underbead cracking under all conditions.

COST AND WEIGHT SAVINGS

Where design permits the replacement of carbon steel with GLX-W steels, weight savings of 20 to 35 per cent, and cost savings of 10 to 25 per cent can be realized. When replacing alloy steels the cost savings can range from 25 to 35 per cent. These steels feature higher yield strengths, greater tensile strengths and increased toughness without costly heat treatments or extensive alloy additions.

The GLX-W Series is so priced that substantial cost reductions can be obtained by weight reduction over mild carbon steel. Cost reduction can also be obtained over alloy steels because of the lower price of GLX-W steels.

STRONGER AND TOUGHER

GLX-W steels are stronger and tougher than ordinary mild carbon steels and in some applications can do the job now being done by the more costly alloy steels.

MANY USES FOR GLX-W STEELS

GLX-W steels are especially recommended for a broad range of applications in mobile equipment and pressure vessels, as well as the transportation and construction fields.

GLX
W

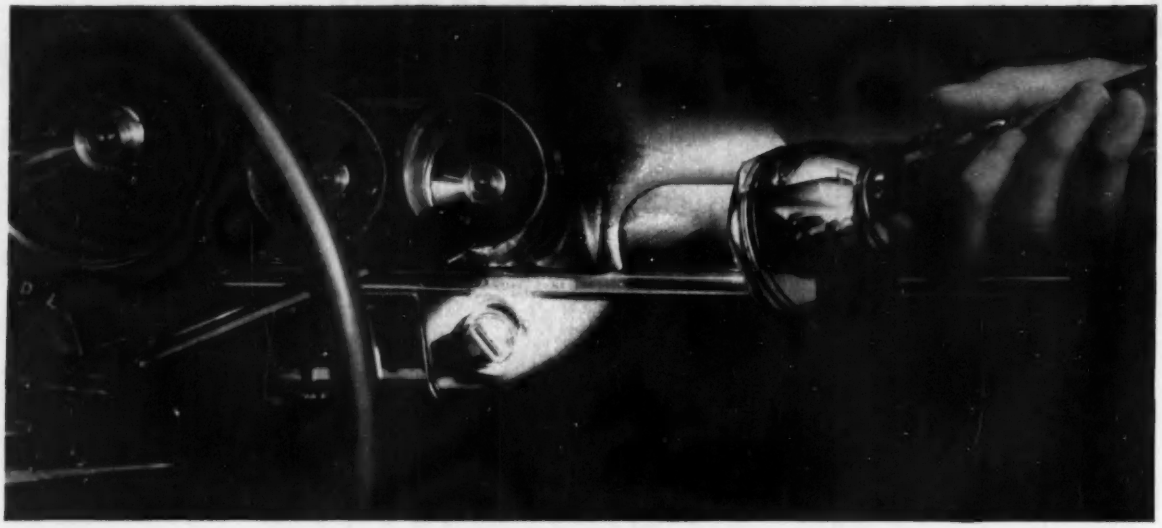
For additional technical information about these economical GLX-W steels write

Product Development Division, Dept. F-1

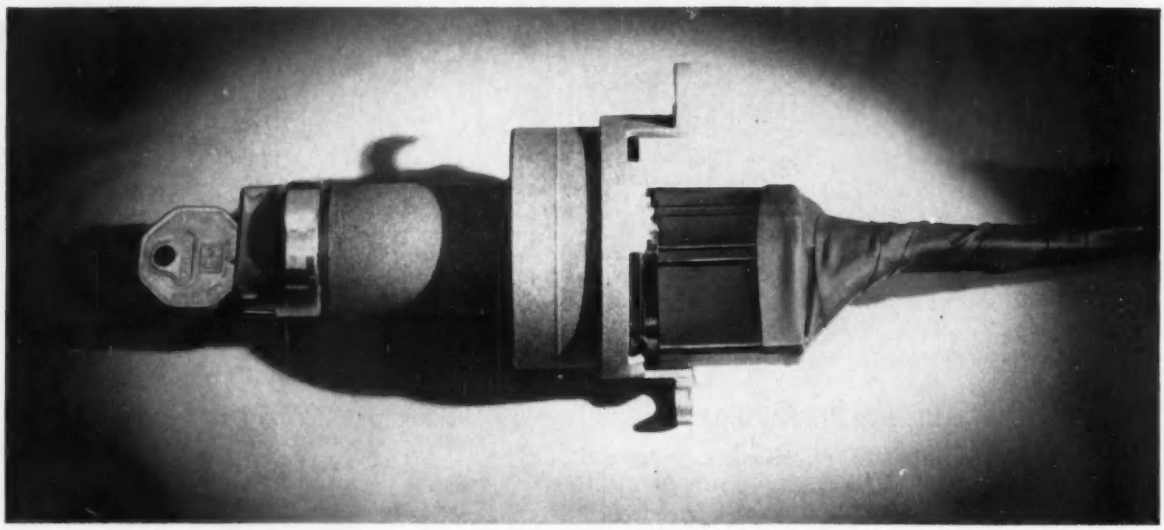
GREAT LAKES STEEL CORPORATION

Detroit 29, Michigan • Division of

NATIONAL STEEL CORPORATION



CAR THEFT / *Easily removed ignition switch connectors*



FOILED / *now replaced by Packard lock-on connector!*

Locked-in ignition wires will discourage almost any car thief. And that's what Packard's new lock-on ignition switch connector does—locks wires in tight! This extra protection from theft is achieved by a slight, but ingenious, modification in the design of the plastic connector. There is *no increase* in the cost of the part.

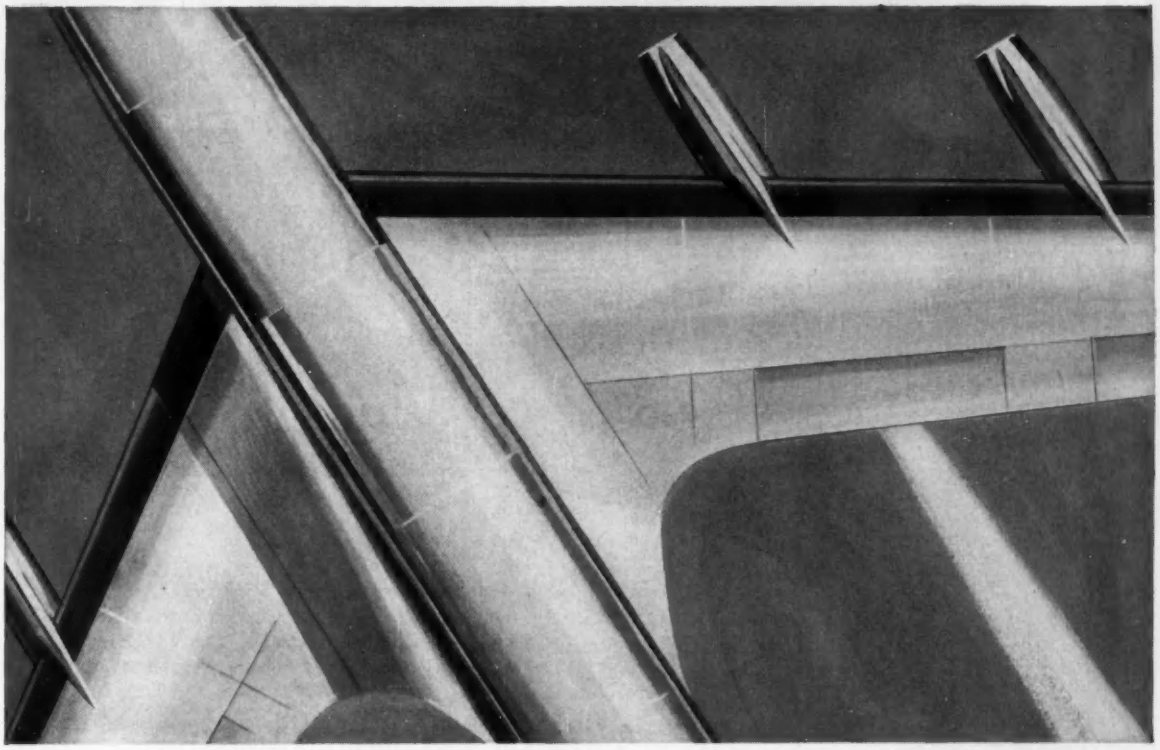
Lock-on connectors are but one example of the added value and benefit designed and built into every Packard product by the world's largest manufacturer of automotive wiring systems. The specialized knowledge of Packard Electric engineers and Packard's outstanding production know-how and facilities can give you what you want, when you want it. And one-source service saves on accounting, inventory, paper work. Packard Electric sales and engineering offices are located in Detroit, Chicago, and Oakland, California.

Packard Electric

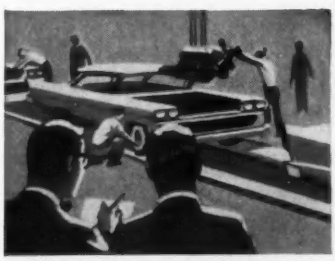
Warren, Ohio GM GENERAL MOTORS

"Live Wire" division of General Motors

Specify the Filter that America Ranks First!



FIRST WITH THE "BOEING 707"—America's first jet airliner! Engines on this giant airliner consume large quantities of fuel which must be finely filtered to assure proper operation. *FRAM filters are chosen to do the job!*



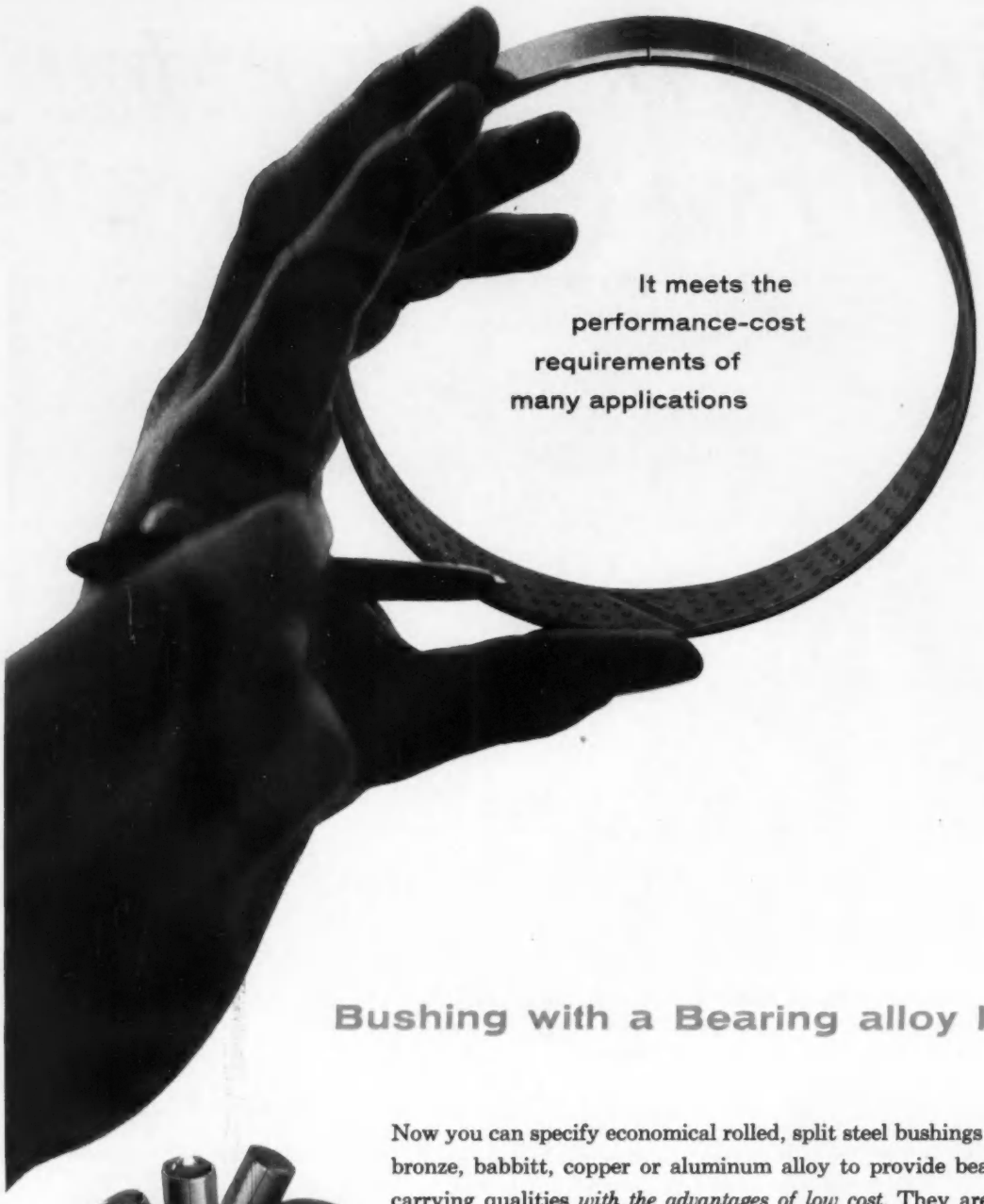
FIRST WITH CAR MAKERS! In today's cars, both oil and air pour through the engine at higher speeds than ever before! This fast-flowing oil and air must be cleaned by filters tailored to each car model. *More car makers install FRAM at the factory than any other filter!*

FIRST WITH DRIVERS! Among the millions of car owners who now know car filters by brand name—*more rank FRAM first in quality than any other filter!*

FRAM ENGINEERS are continually at work developing advanced filtering methods to meet the rigid requirements of today's gasoline, diesel, and jet engines. At FRAM Research and Testing Laboratories, the filtering problems of all types of engine manufacturers are met and solved. For the filter your engine demands, specify the *one* that America ranks first . . . FRAM.

FRAM CORPORATION, PROVIDENCE, RHODE ISLAND

FRAM
OIL AIR FUEL WATER
FILTERS



Bushing with a Bearing alloy lining

Now you can specify economical rolled, split steel bushings lined with bronze, babbitt, copper or aluminum alloy to provide bearing load-carrying qualities *with the advantages of low cost.* They are available in many lengths and diameters, with straight, clinch, butt or special seams. They can be ball indented and have oil holes, grooves, notches, slots, as required. Quality controlled manufacturing to meet your specifications. We provide complete engineering service. A copy of the "Formed Bushing Design Guide" will be sent on request.

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11035 SHOEMAKER, DETROIT 13, MICHIGAN

more air reserve for safer braking...

Wagner ROTARY AIR COMPRESSORS

provide rapid pressure recovery to assure ample air at all times

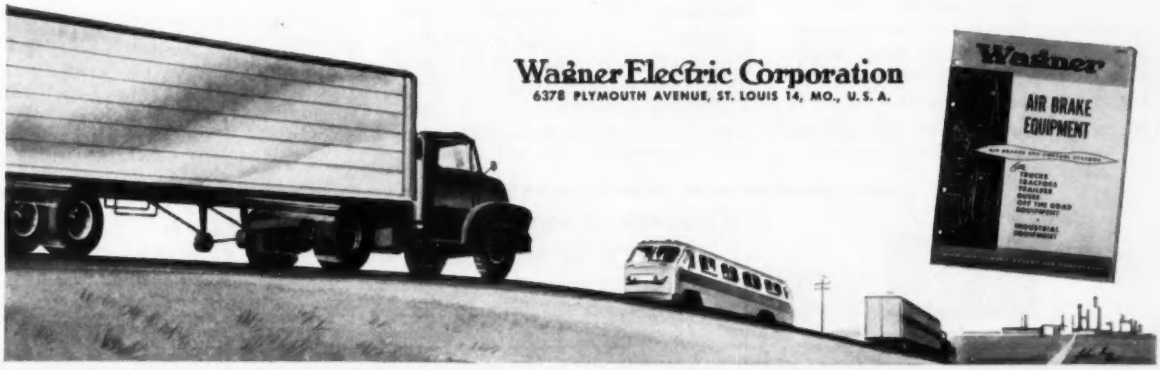
Wagner Rotary Air Compressors have what it takes to deliver a constant and smooth flowing supply of compressed air at all times. Their ability to provide rapid pressure recovery means safer stopping power even under the most severe braking conditions.

Rotary compression forces all air from the compression chamber. Oil and air are separated and cooled before air is discharged to prevent carbon formation in air lines. All rotating parts are turned by the rotor shaft which is suspended on two bearing surfaces to lower friction loss. Uniform torque load with moderate stresses assures smooth, quiet operation with long belt life even at high compressor speeds.

Field tests and fleet records show that Wagner Rotary Air Compressors help keep air brake maintenance costs down. Their exceptionally long service life and easy, infrequent preventive maintenance adds up to greater economy . . . greater performance . . . greater safety. Available in either 9 C.F.M. capacity, air or water cooled; or 12 C.F.M. capacity, water cooled.

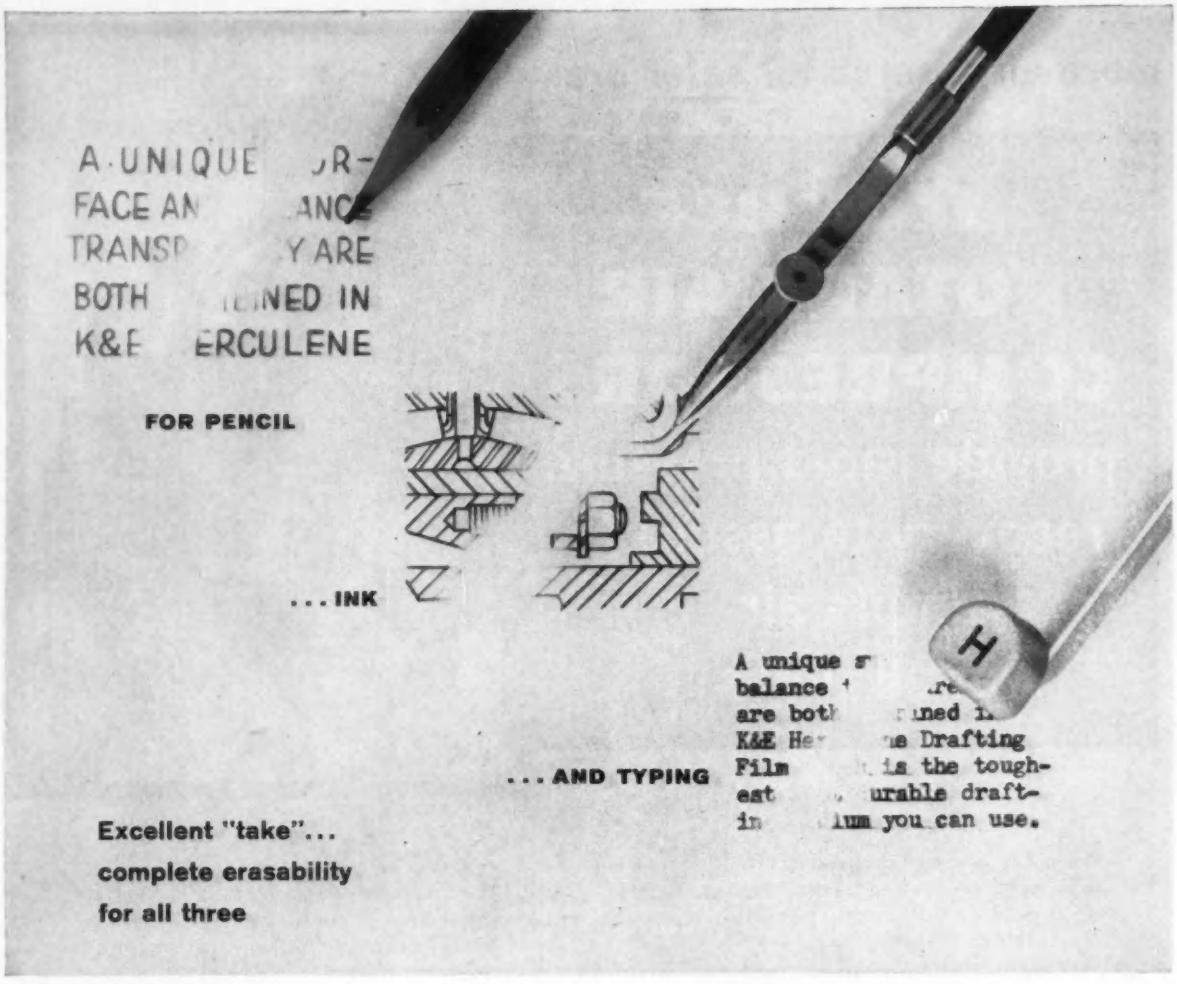
For full information about these compressors and details on complete Wagner Air Brake Systems and Equipment for trucks, trailers, tractors, buses and off-the-road equipment, send for your free copy of Wagner Catalog KU-201.

WK59-2



Wagner Electric Corporation
6378 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

LOCKHEED HYDRAULIC BRAKE PARTS, FLUID and BRAKE LINING • AIR HORNS • AIR BRAKES • TACHOGRAPHS • ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES



Now K&E provides the ultimate "3-way" surface for super-tough HERCULENE™ Drafting Film

Only K&E Herculene Drafting Film has a surface perfectly engineered for pencil, ink and typing . . . plus the extreme toughness and durability of a DuPont "Mylar®" film base. You get the absolute assurance of superior "take". And Herculene erases easily and quickly without the need for erasing or correcting fluids.

Virtually indestructible, Herculene is so tough you can hardly tear it. It can't be damaged by moisture. And it's permanent . . . your drawings are resistant to damage by aging or handling.

Herculene has "balanced" transparency . . . just the right combination of high actinic transparency for reproduction with essential visual opacity for drafting. You get sharp, legible reproductions at high machine speeds. And you can make prints from a Herculene Drawing indefinitely without its yellowing or tearing, cracking or becoming brittle.

Herculene is economical too . . . now costs *less* than cloth. Prove these facts for yourself by writing today for a free sample. Just clip and mail the coupon below.

KEUFFEL & ESSER CO., Dept. SJ-1, Hoboken, N. J.
I want to see a sample of the new K&E Herculene.

Name & Title: _____

Company & Address: _____

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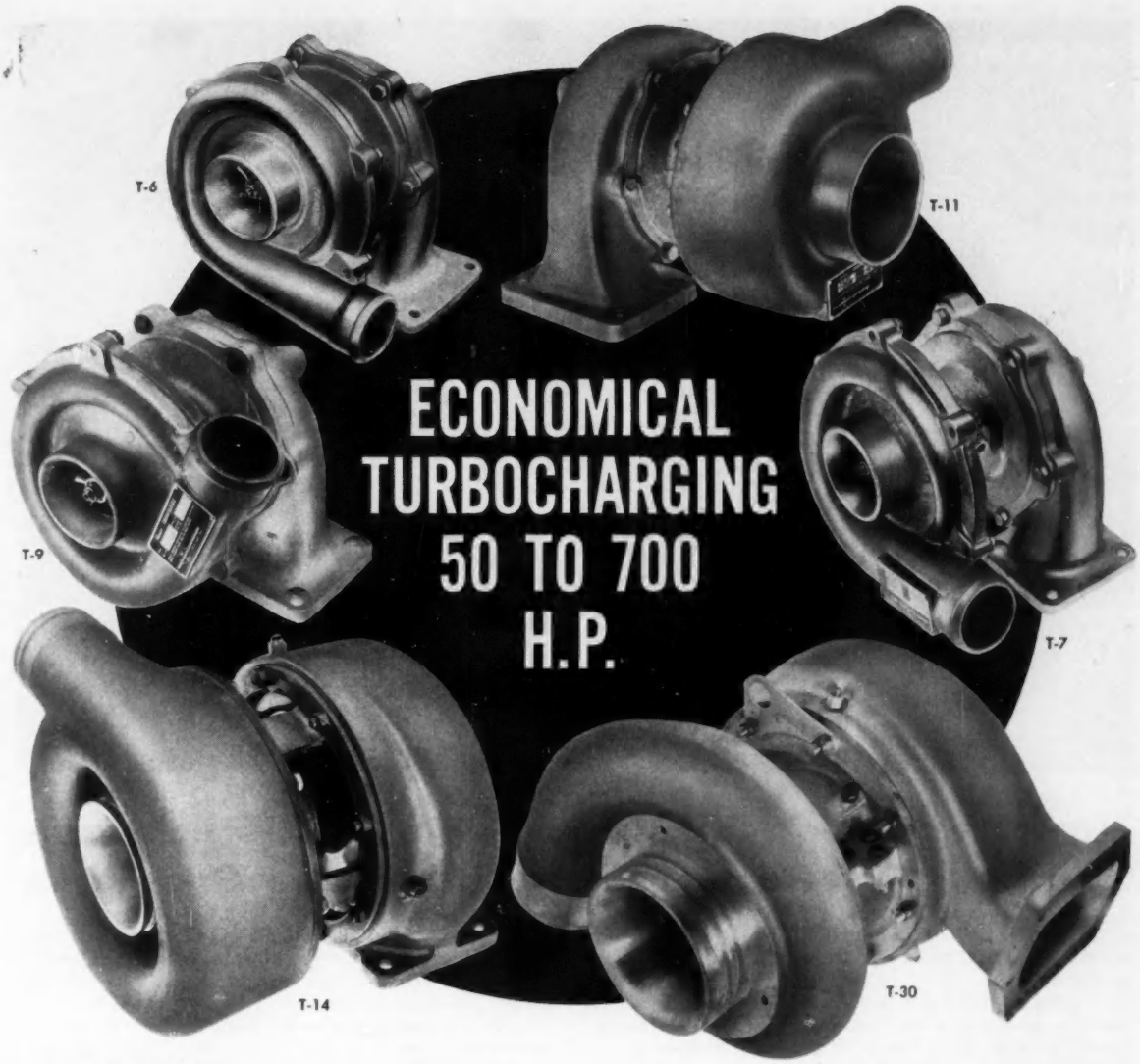


ECONOMICAL TURBOCHARGING 50 TO 700 H.P.

AIRESEARCH now offers to the diesel engine manufacturer a complete line of turbochargers for automotive, stationary and marine engines covering the turbocharged range 50 to 700 horsepower for single installations. This family of improved turbochargers maintains excellent performance levels throughout the entire range of power, and allows greater ease of servicing through standardization and simplified design.

The reduced cost, light weight and high output of this turbocharger family enables the diesel industry to gain more horsepower per unit cost than has been possible before. They are especially effective in the low horsepower ranges where they make turbocharging of the smaller diesels economically practical for the first time. In addition, use of the AiResearch turbocharger control systems and intercoolers provides the most effective turbocharging available by accurately controlling turbocharger speed over its complete range regardless of changing load characteristics.

AiResearch has sold more than 20,000 turbochargers, accounting for more than six million horsepower now in operation, and is the largest and most experienced manufacturer of lightweight turbomachinery of all types.

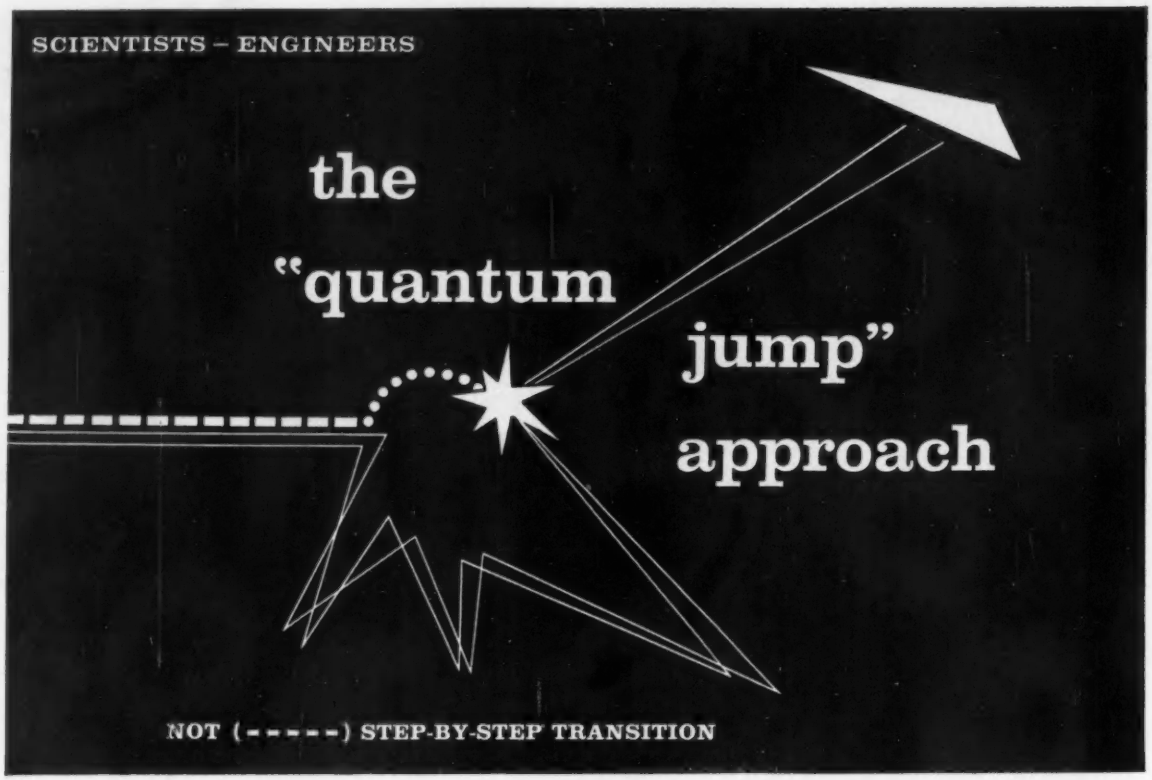
Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS



How Republic's Engineers & Scientists Attack Today's Missile, Aircraft and Space Problems

There's something in the environment at Republic Aviation that fires the imagination and sharpens the logical faculties.

You find it, at its quintessence, within the research groups, whose members have recently come up with a feasible design for a "Magnetic Pinch Plasma Engine" to operate in space. *A design utilizing a novel application of basic knowledge in the field of magneto-hydrodynamics.*

The same spirit of bold inquiry, of looking beyond the immediate, conventional solution of a problem for new and better answers, permeates the entire professional staff. You'll find it in development engineers working on new missiles for new missions . . in experimental engineers studying the behavior of a prototype aircraft. You'll find it in the metallurgical and electronics labs.

THE RESULT – "quantum-jump" advances in many technologies vital to the conquest of upper atmosphere and space flight.

Engineers and Scientists who share Republic's views on Creative Problem-Solving are invited to discuss opportunities now open in the following areas:

THERMO, AERODYNAMICS

Theoretical Gasdynamics • Hyper-Velocity Studies • Astronautics Precision Trajectories • Airplane/Missile Performance • Air Load and Aeroelasticity • Stability and Controls • Flutter & Vibration • Vehicle Dynamics & System Designs • High Altitude Atmosphere Physics • Advanced Propulsion • Engineer Performance • Re-entry Heat Transfer • Supersonic/Hypersonic Wind Tunnels • Shock Tunnel • Plasma Tunnel • Magneto-Hydrodynamics • Ground Control Equipment

ELECTRONICS

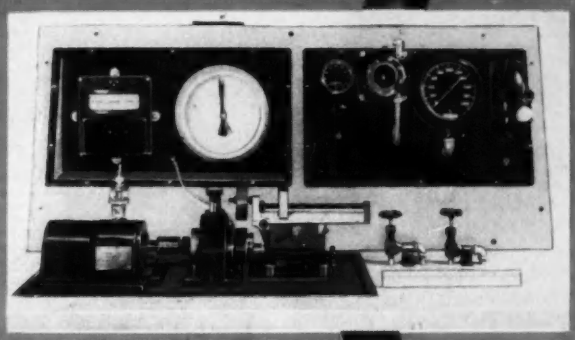
Inertial Guidance • Inertial Navigation • Digital Computer Development • Radar Design • Systems Engineering • Telemetry-SSB Technique • Information Theory • Doppler Radar • Countermeasures • Radio Altimeters • Radome & Antenna Design • Microwave Circuitry & Components • Receiver & Transmitter Design • Airborne Navigational Systems • Missile Checkout Systems • Missile Arming & Fusing • Jamming & Anti-Jamming • Miniaturization-Transistorization • Ranging Systems • Propagation Studies • Ground Support Equipment

REPUBLIC AVIATION is investing $35,000,000 in bold new R & D Program designed to arrive at Major Breakthroughs inTransition from Aeronautics to Astronautics.

Send resume in complete confidence to:
Mr. George R. Hickman, Engineering Employment Manager

REPUBLIC AVIATION
Farmingdale, Long Island, New York

Low Cost Rotary Seals



Precision test stand especially developed to test efficiency of "O" rings as low cost rotating shaft seals.

Precision "O" Rings from Compound 158-80 provide the answer to a problem for a manufacturer of Oil-Hydraulic Pumps.

1. Eliminated costly hand lapping
2. Reduced friction—increased life
3. Sealed 2000 P.S.I.

Compound 158-80, with built in lubrication, is especially suitable for those jobs where friction is a problem. They are compression molded, rigidly inspected —the finest made!

Have a sealing problem? You'll find the answer at Precision! There's a Precision engineer ready to help you in "O" Ring specification and product design.

Get your free copy of our Engineering Data Sheet on Compound 158-80.

Specify Precision—first in quality

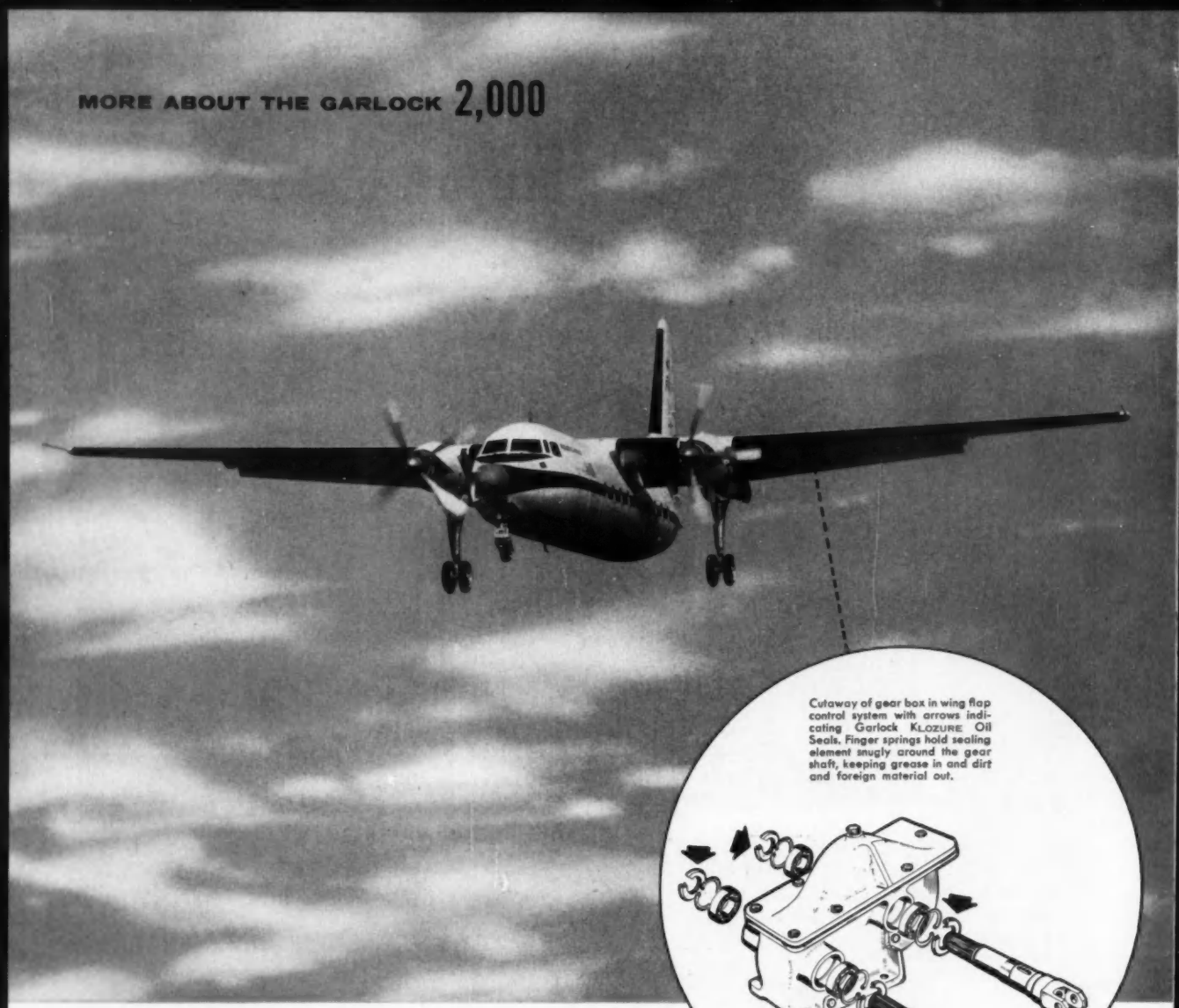
Precision Rubber Products Corporation

"O" Ring and Dyna-seal Specialists

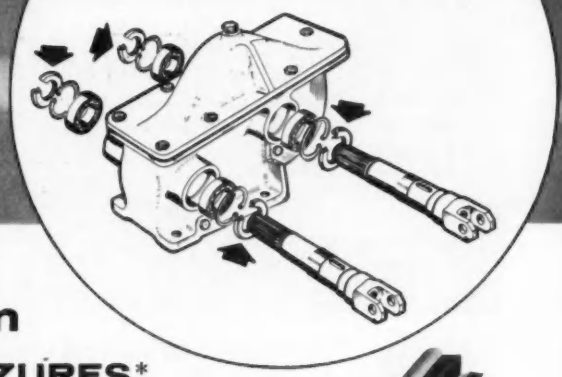
3110 Oakridge Drive, Dayton 7, Ohio

Canadian plant at: Ste. Thérèse de Blainville, Québec

MORE ABOUT THE GARLOCK 2,000



Cutaway of gear box in wing flap control system with arrows indicating Garlock KLOZURE Oil Seals. Finger springs hold sealing element snugly around the gear shaft, keeping grease in and dirt and foreign material out.



F-27 Flap Control System Sealed with Garlock KLOZURES*

Garlock KLOZURE Oil Seals contribute to the superb performance of the new Fairchild F-27 Propjetliner. 36 Garlock KLOZURES are located in 12 gear boxes in the wing flap control system. This system is instrumental in providing exceptional good landing and take-off performance.

The flaps are operated by an electric motor and reduction gear train. A total of 12 gear boxes are driven by means of a torque tube extending across the airplane to the outboard ends of the flaps. KLOZURES seal in the lubricating oil on the shafts providing dependable, trouble-free operation.

Why not let Garlock solve your difficult sealing problems. Your Garlock representative can recommend from "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. It's the only complete line in the industry. Call him or write for Catalog 20.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada.

Cross-section of Garlock KLOZURE Model 63 designed for normal and high speed service, and used on the F-27. Exclusive Garlock sealing element is non-abrasive, free-running; resistant to oil, water, grease, heat and cold. Sealing elements of silicone rubber or Viton A for temperature extremes are also obtainable.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

*Garlock Trademark

VARIABLE* RATIO STEERING

*Originated and developed by . . .

Ross STEERING

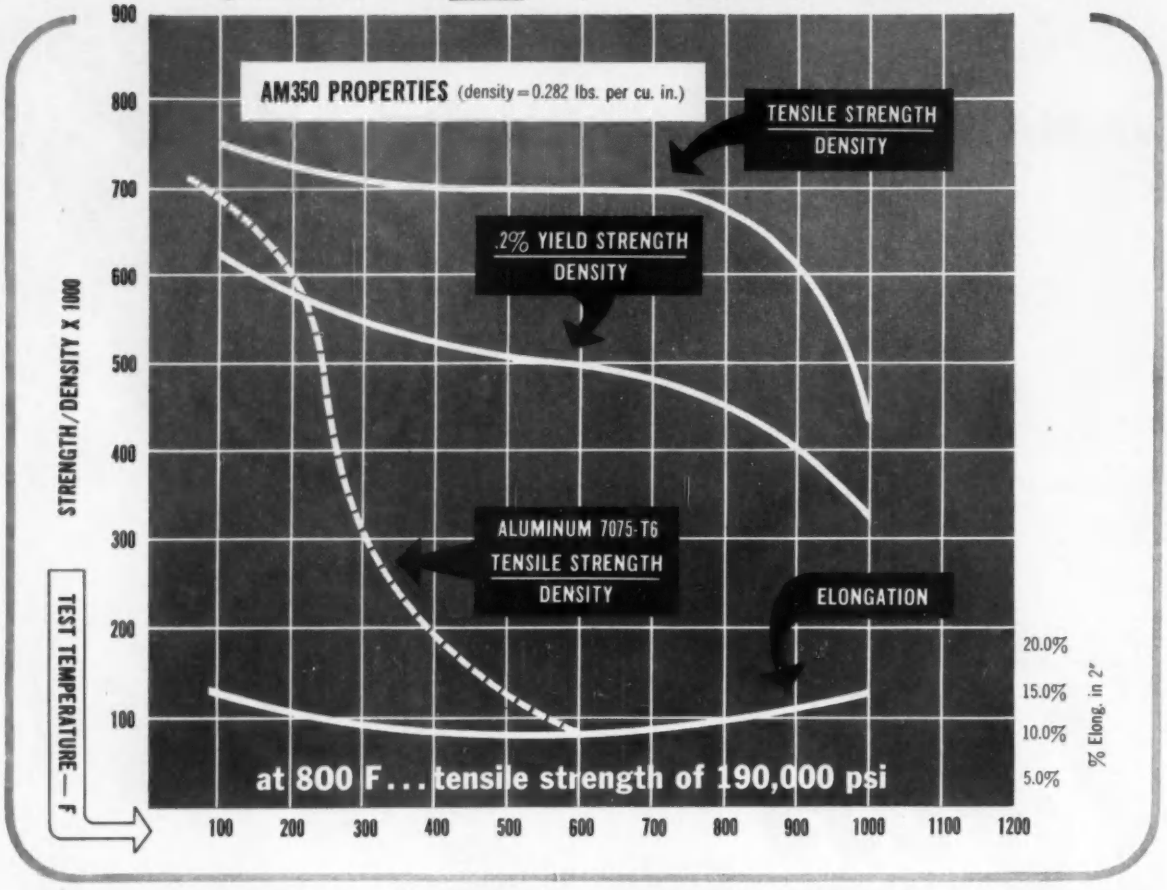
Faster steering and quicker recovery for cornering . . . **slower** steering and greater stability for straight-ahead handling! These are the twin benefits of **variable-ratio** steering, originated and developed by Ross. Steering specialists since 1906, Ross provides the right gear for every steering need—manual or power, constant or variable ratio. Ross invites *your* steering inquiry.

ROSS GEAR AND TOOL COMPANY, INC.
LAFAYETTE, INDIANA
Gemmer Division—Detroit

Variable ratio 12:20:12 . . . 12 to 1 ratio for cornering and 20 to 1 for straight ahead handling . . . 3 turns of wheel from lock to lock.

Constant ratio 22:22:22 . . . 22 to 1 ratio for cornering and 22 to 1 for straight ahead handling . . . 5 turns of wheel from lock to lock.

Experience—*the extra alloy in* **Allegheny Stainless**



Here are the facts on AM350 and AM355, Allegheny Ludlum's precipitation hardening stainless steels

A unique combination of highly desirable properties is the usual description of Allegheny Stainless AM350 and AM355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many problems of the air age. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM350 and AM355.

Availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available in forgings, forging billets, plate, bar and wire.

Corrosion resistant: Being stainless steels, these alloys resist corrosion and oxidation. Compared to the older, more familiar stainless grades, their corrosion rating is better than the hardenable grades (chromium martensitic) but generally less than the old corrosion resistant standbys, the 18 and 8's. Stress corrosion is resisted at much higher hardness levels than with martensitic stainless.

Simple heat treatment: High strength is developed by two methods, both involving less than ordinary temperatures and minimizing oxidation and distortion problems. The most popular, and one that develops slightly better properties, is the Allegheny Ludlum developed sub-zero cooling and tempering (SCT condition). The material is held at minus 100 F for 3 hrs plus 3 hrs at 850 F. Alternate method is Double Aged (DA): 2 hrs at 1375 F plus 2 hrs at 850 F.

Easy fabrication: AM350 and AM355 can be spun, drawn, formed, machined and welded using similar procedures as with the 18-8 stainless types. In the hardened condition (SCT & DA) some forming may be done . . . 180 degree bend over a 3T radius pin. Also it can be dimpled in the hard condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*** Address Dept. SA-13.

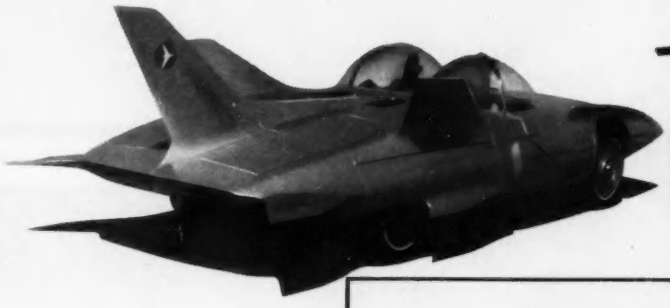
WSW 7327

ALLEGHENY LUDLUM

Export distribution: AIRCO INTERNATIONAL

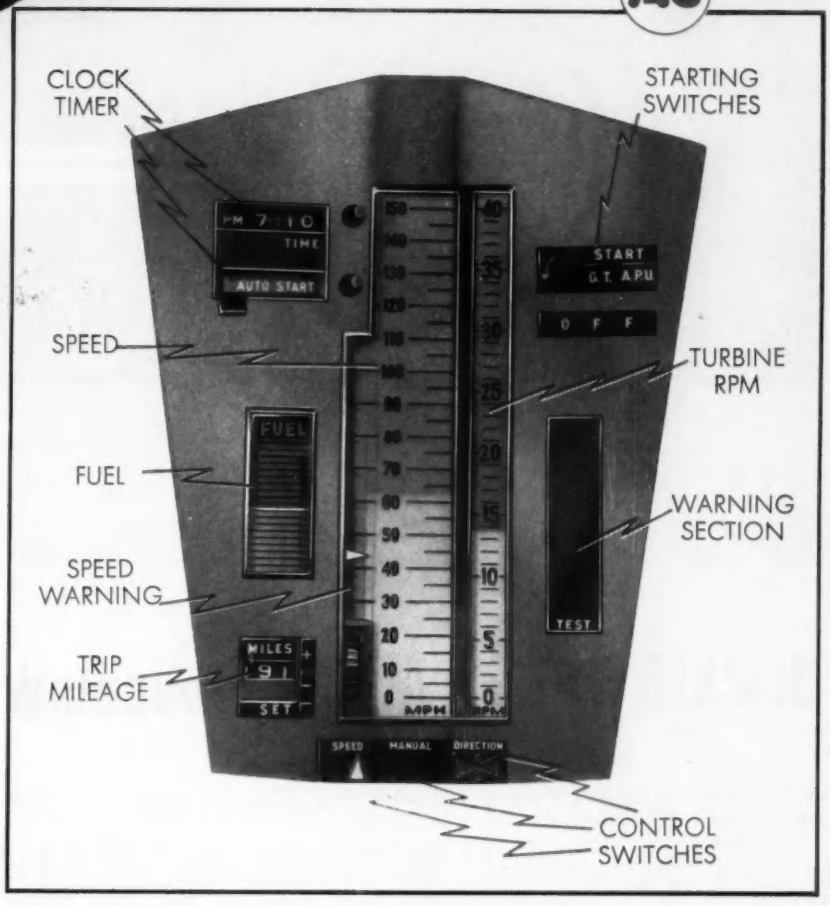
EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

GM Firebird's ELECTRONIC BRAIN BY AC



"These instruments for the first time make effective use of electronic techniques in an automotive instrument panel."

J. A. ANDERSON
VICE PRESIDENT, General Motors Corporation
GENERAL MANAGER, AC Spark Plug Division



"We think the industry will find these devices interesting and challenging!," Anderson says. "In addition to reporting such normal operating conditions as speed, fuel supply, mileage travelled and turbine RPM, a WARNING SECTION also lights up to notify the driver of possible malfunction in one or more of 13 other areas. When the WARNING SECTION is dark, the driver knows the car is functioning perfectly. Though futuristic in its concepts, the Firebird III Instrumentation is just one more example of AC Engineering Creativity available to you by contacting any AC Office."

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

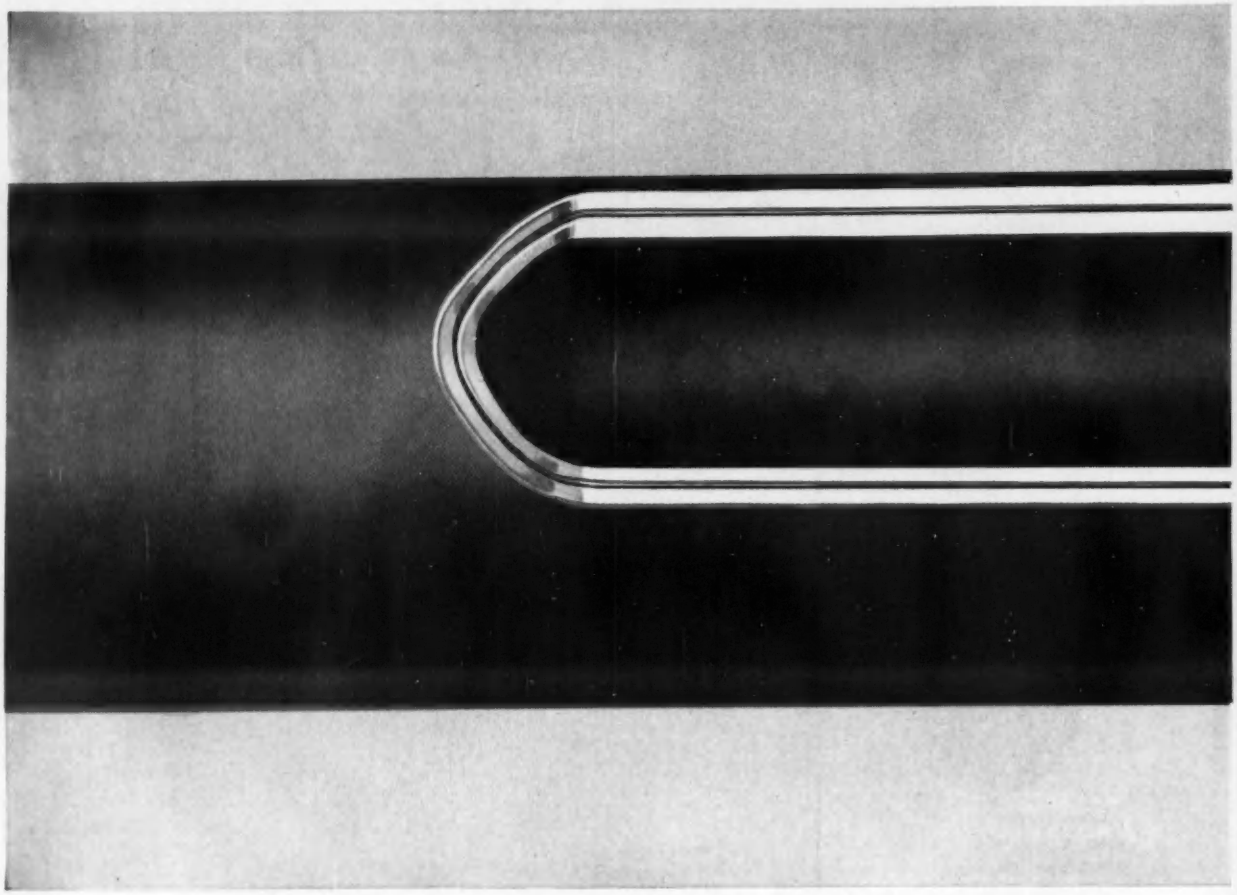
AC

QUALITY PRODUCTS

FLINT—1300 North Dort Highway, CEdar 4-5611
CHICAGO—7074 North Western Avenue, Rogers Park 4-9600
DETROIT—General Motors Building, TRinity 5-2630

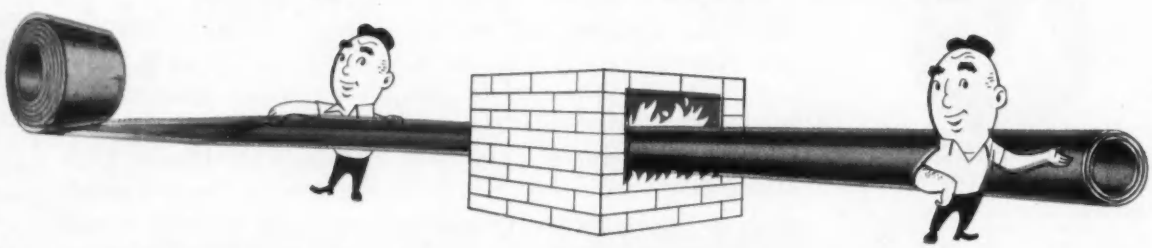
Watch Walt Disney Studios' ZORRO every week on ABC-TV

WHY BUNDY LEADS IN MASS-FABRICATION:



DOUBLE FLARE...Another reason why Bundyweld

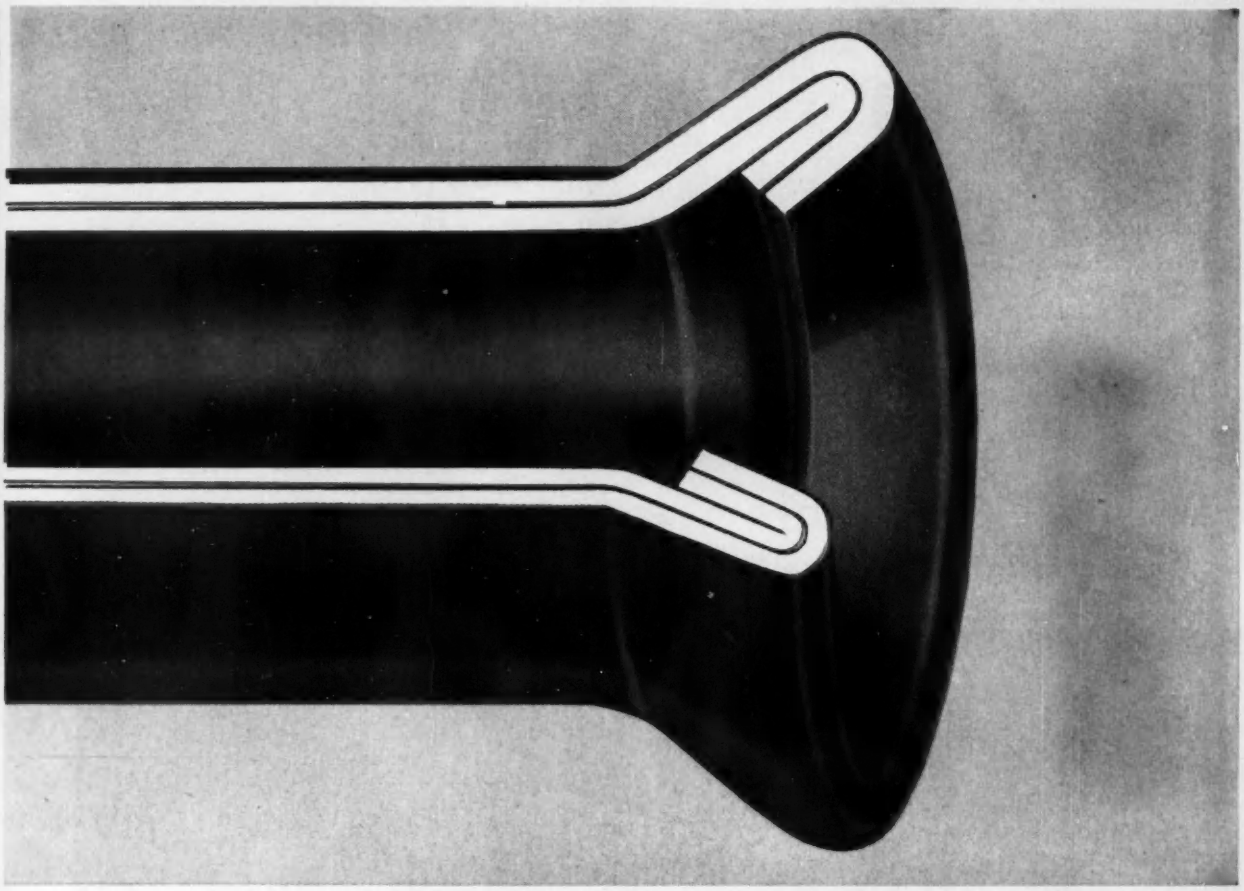
And Bundyweld can be mass-fabricated to any specifications you give—at a low cost made possible by three Bundy advantages:



Bundyweld starts as a single strip of copper-coated steel. Then it's continuously rolled twice around laterally . . .

into a tube of uniform thickness, and passed through a furnace where copper coating fuses with basic steel.

Result: Bundyweld Tubing—double-walled, beadless, metallurgically bonded through 360° of wall contact.



Cutaway of Bundy double flare (greatly magnified) that puts almost *twice* the metal at the seat.

insures extra brakeline safety

This is the famous Bundy® double-flare—developed to take high wrench-torque and frequent uncouplings . . . and still carry high-pressure hydraulics *with perfect safety*. It's just one example of how Bundy leads in *mass-fabrication* these three ways:

1. The tubing itself—Bundyweld®, double-walled from a single steel strip. It stands up against brutal shocks and vibration fatigue. That's why it's on 95% of today's cars, in an average of 20 uses each.

2. Bundy design service—Skilled engineers are on call at any stage in the development of your product. Often they'll suggest short-cuts to trim costs.

3. Bundy fabrication service—Trained technicians man Bundy-designed machines . . . turn out parts to your specifications at lowest unit cost.

Add it up—then check *first* with Bundy for the finest in small-diameter tubing plus unmatched design and fabrication service. Contact us today!

BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

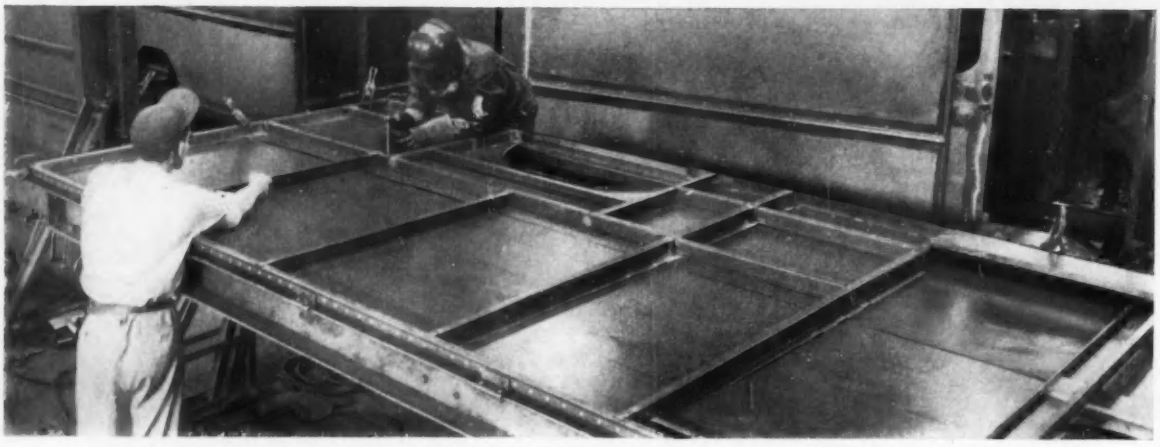
WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

There's no real substitute for

BUNDYWELD® TUBING

Bundyweld and Bundy specialty tubings are sold through distributors in principal cities

"Better-Built"... greater strength, lighter



weight with Nickel-copper alloy steel

See the weldor joining a frame of Cor-Ten*Nickel-copper high strength low alloy steel to a body sub assembly?

Soon this sub assembly will be on the main body assembly line at Boyertown Auto Body Works. Total weight of the Boyertown truck body will average 25 to 40% lighter than the same size bodies made of carbon steel.

And because minimum yield strength . . . 50,000 psi . . . of Ni-Cu steels is about 1½ times that of carbon steel, this savings in weight will be made without sacrificing strength, safety, or service life.

You can do the same with your commercial vehicles.

You can cut deadweight without decreasing body strength . . . and at the same time meet high production schedules because of the steels' ready weldability and formability.

What's more, high strength low alloy Nickel-copper steels provide 4 to 6 times greater resistance to atmospheric corrosion than do carbon steels which means longer paint life. They resist shock, battering and abrasion better, too.

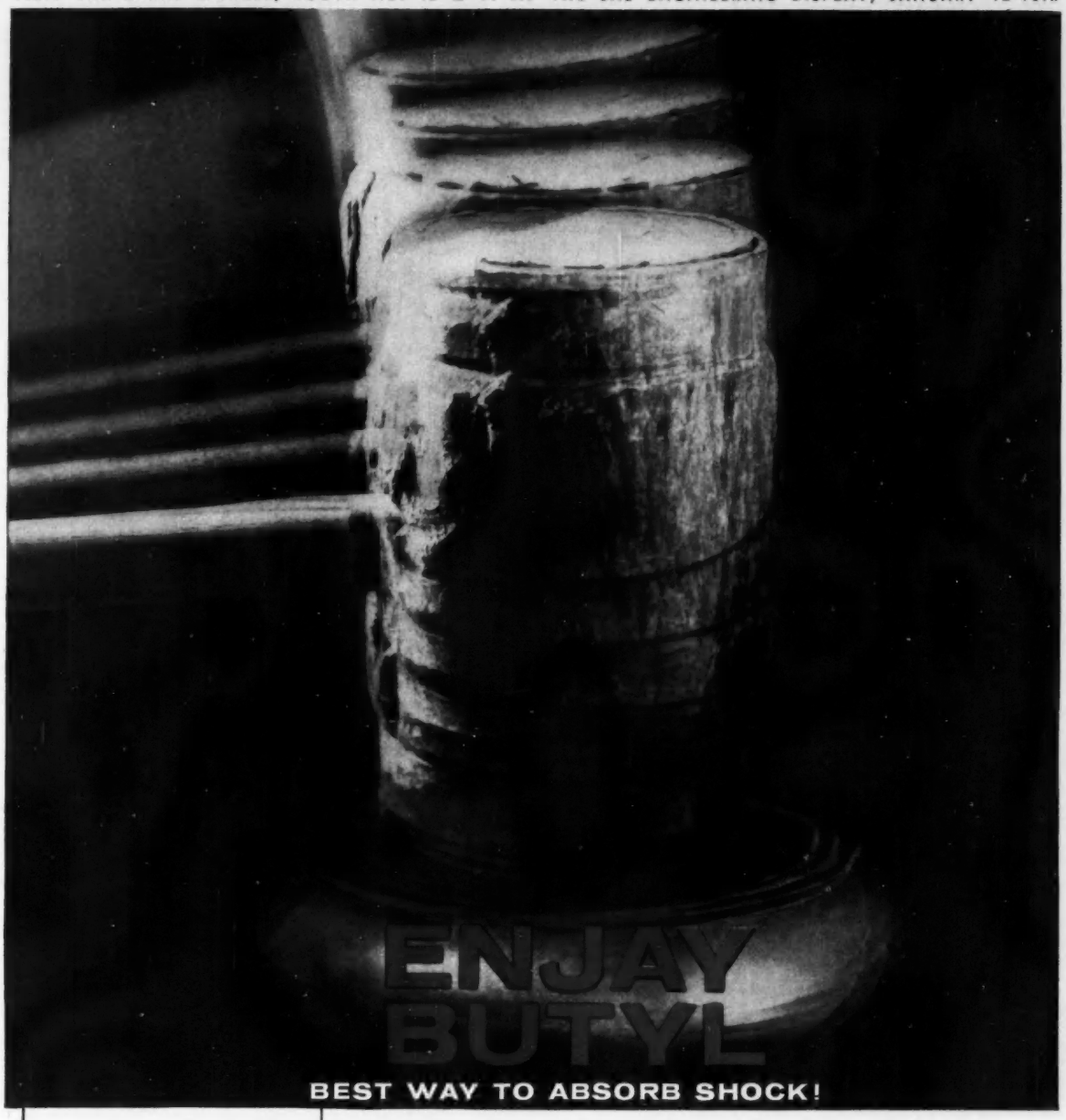
If you'd like more information about high strength low alloy steels . . . properties, design factors, fabrication . . . write to Inco.

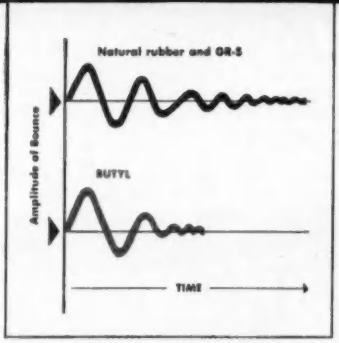
*Trademark U. S. Steel Corporation

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER





Butyl's superior shock absorption characteristics reduce amplitude of bounce in much less time as compared with other rubbers.

Enjay Butyl, because of its higher damping factor, absorbs shock energy *more* completely than any other rubber. Through simple variations in compounding or processing, you can build the right degree of resiliency for your requirements. Butyl is the ideal rubber for motor mounts, load cushions, sound deadener insulation, axle and body bumpers—and other shock, noise and mechanical vibration applications.

Butyl *also* offers outstanding resistance to weathering and sunlight . . . chemicals . . . heat . . . abrasion, tear and flexing . . . unmatched electrical properties and impermeability to gases and moisture.

Find out how this versatile rubber can improve your product. Call or write the Enjay Company, today!

ENJAY® BUTYL

ENJAY *Pioneer in Petrochemicals*

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Akron • Boston • Charlotte • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

NEW TUNG-SOL

HEAVY DUTY FLASHER

...built with

twice the life

for trucks, buses, and all other fleet vehicles

The new Tung-Sol heavy duty flasher has a service-rated life of twice that of any other type. It can be used to flash one to six lights without a perceptible change in the flashing rate. It provides for instantaneous four-lamp emergency warning—and it will replace 95% of the flashers now in use. This new flasher will provide more positive action and greater dependability in any service for which the vehicle is presently wired. Made in the universal form, it can be used in either a plug-in or a screw terminal installation. Electroswitch Division, Tung-Sol Electric Inc., Newark 4, N. J.

6 and 12-Volt Types

6-Volt—#535 flashes from one to six 21cp lamps

12-Volt—#534 flashes from one to six 21cp or 32cp lamps

TUNG-SOL® — *First in Flashers*

FOR BETTER CASTINGS FROM THESE METALS

REICHHOLD CUSTOMERS RECOMMEND THESE PROVEN PRODUCTS

METAL	RCI PRODUCTS	DESCRIPTION	OUTSTANDING FEATURES
IRON (GREY, MALLEABLE, NODULAR, HIGH ALLOY)	FOUNDREZ 7101, 7102, 7103, 7104	LIQUID PHENOLIC CORE BINDING RESINS	HIGH HOT STRENGTH HIGH BAKED STRENGTH
	FOUNDREZ 7600, 7601, 7605	LIQUID AMINO CORE BINDING RESINS	RAPID COLLAPSIBILITY FAST BAKE — LESS SMOKING
	CO-RELEES 7300	LIQUID SAND CONDITIONER	EXCELLENT SAND WORKABILITY
	coRCIment 7990, 7991, 7992, 7993	LIQUID OLEORESINOUS CORE BINDERS	BROAD BAKING RANGE
	FOUNDREZ 7150, 7151	LIQUID PHENOLIC RESINS FOR SHELL COREMAKING	UNUSUAL STABILITY
	FOUNDREZ 7500, 7504, 7506, 7555	POWDERED PHENOLIC RESINS FOR SHELL MOLDING	SELF-ACTIVATION
	FOUNDREZ 7520	GRANULATED PHENOLIC RESIN FOR SHELL MOLDING	HIGH TENSILE STRENGTH
	COROVIT 7201, 7204	POWDERED ACCELERATORS FOR COROVIT OILS	NON-TOXICITY
	COROVIT 7202, 7203	LIQUID BINDERS (SELF-CURING)	EXCELLENT FLOWABILITY
STEEL (STAINLESS, LOW CARBON, HIGH CARBON)	FOUNDREZ 7104	LIQUID PHENOLIC CORE BINDING RESIN	EXCEPTIONAL STABILITY HIGH HOT STRENGTH HIGH BAKED STRENGTH
COPPER ALLOYS (BRASS, BRONZE)	FOUNDREZ 7605	LIQUID AMINO CORE BINDING RESIN	FAST BAKE LESS SMOKING
LIGHT ALLOYS (ALUMINUM, MAGNESIUM)	FOUNDREZ 7605	LIQUID AMINO CORE BINDING RESIN	RAPID COLLAPSIBILITY

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IMPROVED CHARACTERISTICS

...OF SPECIAL INTEREST TO AUTOMOTIVE ENGINEERS

DELCO HIGH POWER TRANSISTORS

UNEXCELLED FOR SWITCHING, POWER HANDLING, EFFICIENCY, RELIABILITY

TYPICAL CHARACTERISTICS AT 25°C.

	†2N1100	‡2N1099	*2N174A	2N174	2N173	2N278	2N277	2N443	2N442	2N441
Maximum Collector Current	15	15	15	15	15	15	15	15	15	15 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	50	40	60	50	40 volts
Saturation Resistance	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03 ohms
Thermal Gradient (Max.) (Junction to Mounting Base)	.8	.8	.8	.8	.8	1.0	1.0	1.0	1.0	1.0 °C/watt
Base Current I_B (V_{EC} = 2 volts, I_C = 5 amps)	135	100	135	135	100	100	100	150	150	150 ma
Collector to Emitter Voltage (Min.) Shorted Base (I_C = .3 amps)	80	70	70	70	50	45	40	50	45	40 volts
Collector to Emitter Voltage Open Base (I_C = .3 amps)	70	60	60	60	50	45	40	55	45	40 volts

*Designed to meet MIL-T-19500/13A (Jan) 8 January 1958 †Formerly DT100 ‡Formerly DT80

Check your requirements against the *new, improved* characteristics of Delco High Power transistors. You will find improved collector-to-emitter voltage . . . higher maximum current ratings—15 amperes, and extremely low saturation resistance. Also, note the new solid pin terminal design.

And of special importance to you is the fact that diode voltage ratings are at the maximum rated temperature (95°C.) and voltage.

Write today for engineering data on the *new, improved* characteristics of *all* Delco High Power transistors.

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Division of General Motors · Kokomo, Indiana

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Tel: Mitchell 2-6165

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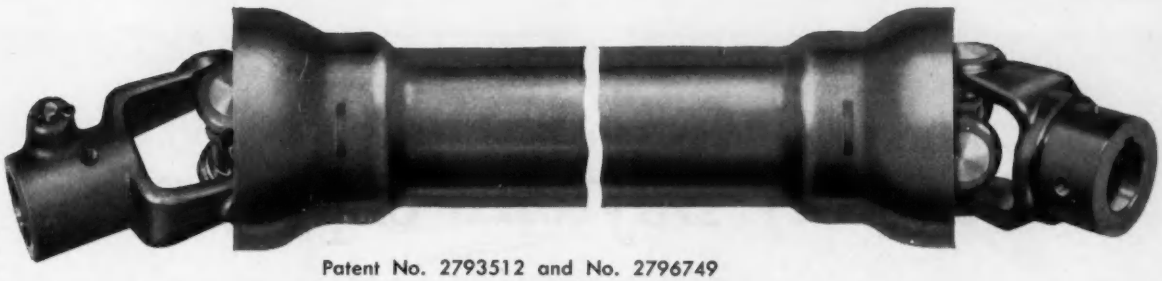


Patent No. 2793512 and No. 2796749

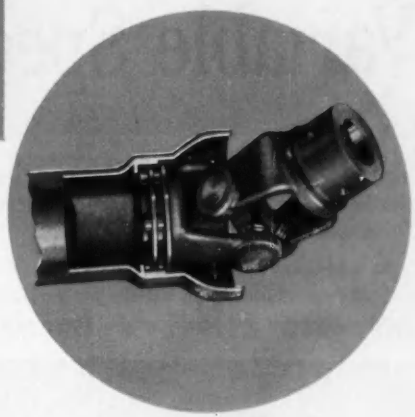
UNIVERSAL SAFETY

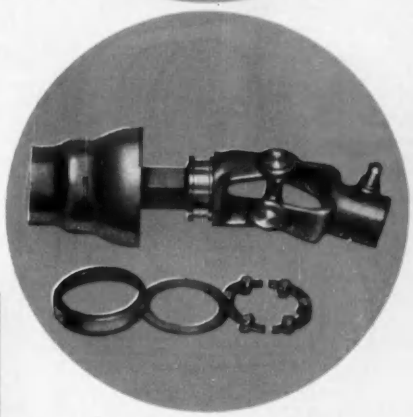
This NEW type MECHANICS SAFETY SHIELD solves many operating problems. True ROLLER BEARINGS provide larger contact area, distribute the load, and avoid trouble caused by ball bearings bursting through the shield. No welds in the shield—leaving longer overlap of shield tubes (with same length shaft) for greater strength. Has fewer parts. Thousands of hours of numerous field operations prove that this NEW design has far longer life than other safety shields. Farm equipment manufacturers everywhere are switching to MECHANICS shields for greater safety. Write for information about sizes, joint types, etc.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2022 Harrison Ave., Rockford, Ill.
Export Sales: Borg-Warner International
36 So. Wabash, Chicago 3, Illinois

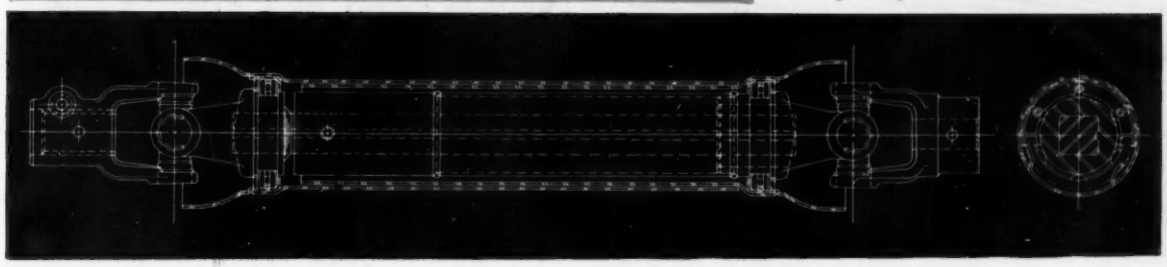
MECHANICS
Roller Bearing BW
UNIVERSAL JOINTS
For Tractors • Trucks and Farm Machines

ROLLER BEARINGS are so tightly sealed-in that dirt and moisture cannot enter.





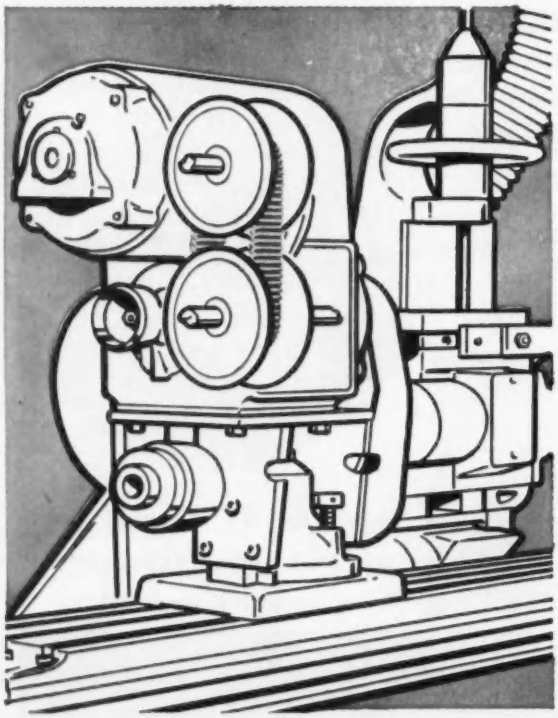
Shield can be removed and serviced by the operator—using only a screwdriver.



Here's why Dayton's experience in supplying 76% of the V-Belts for Variable Speed Drives can help you

Virtually every problem present on *any* V-Belt drive must also be met in building a V-Belt to meet Variable Speed Drive specifications.

In addition, two problems must be overcome, whose difficulty of solution puts V-Belts for variable speed use on the highest level of V-Belt design. These two problems are:



For this rugged sheet metal press, Dayton Double Cog-Belts provide maximum longitudinal flexibility, extra strength and durability to take the high loads, high starting torques of the horizontal Variable Speed drive motor. Exclusive Double Cog design permits use of minimum width pulleys.

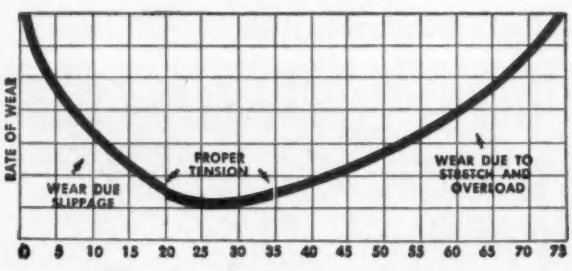
1. Need for extreme longitudinal flexibility coupled with tremendous transverse rigidity to accommodate subdiameter pulleys and maximum axial pressures, and,

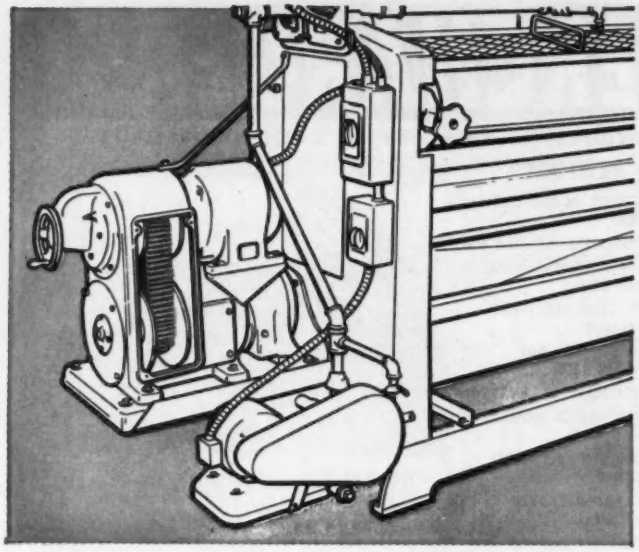
2. Need for a V-Belt of minimum width and thickness capable of meeting the requirements of a full speed range plus the ability to maintain exact speeds at each level.

The ever-increasing market for variable speed drives of higher capacities and greater speed ranges requires a continuing program of V-Belt development. One of the most successful V-Belt designs resulting from this program is the exclusive Dayton Variable Speed Cog-Belt.*

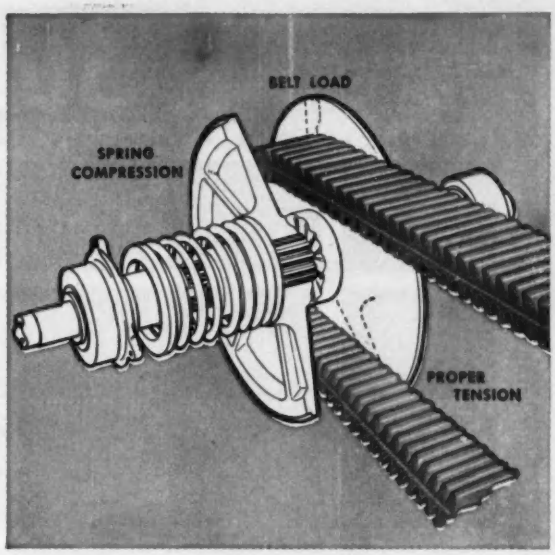
The Dayton Cog-Belt is the closest approach to the theoretical ultimate in V-Belt design, offering the highest pull-out torque of any V-Belt made. For its effective depth it provides a higher degree of longitudinal flexibility than any other V-Belt design and is capable at the same time of withstanding maximum axial pressures. These are among the reasons it is especially adaptable to variable speed service.

Variable speed drive manufacturers have, *through experience,* become convinced of the tremendous worth of Dayton's exclusive V-Belt designs and Dayton's skill in developing internal constructions to meet high and rigid requirements. As a result, Dayton supplies 76% of the V-Belts for the variable speed market.





Vertical variable speed motor on this automatic Glue Spreader receives full, non-slip power from Dayton Variable Speed Cog-Belts. Exclusive double Cog design offers instant speed changes, assures maintenance of constant speeds for all operations.



Tremendous crosswise rigidity is provided by Dayton Double Cog-Belts to maintain precise speed control. Greater surface area rapidly dissipates heat of flexing, prevents heat build-up. Light weight reduces centrifugal forces and internal stresses.

Dayton's experience in building special V-Belts extends into every major field of V-Belt drive design.

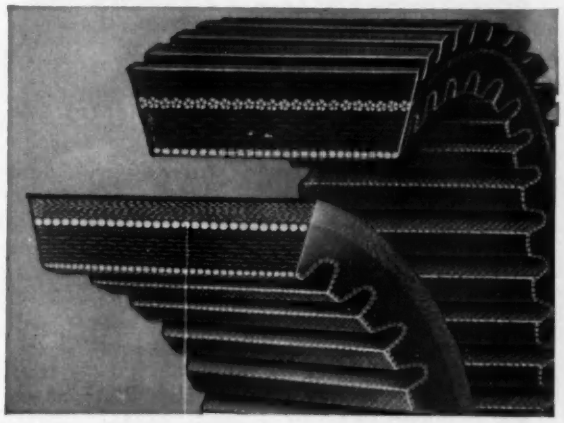
In agriculture, heavy duty variable speed drives are used as traction drives on self-propelled farm implements.

In railway, V-Belts for under car drives for lighting, heating and air conditioning, are required to meet a whole new set of conditions, among them being extremes of weather, misalignment and continuous service.

In household appliances, Dayton is expert in designing and producing FHP V-Belts which will give long, efficient service with almost no maintenance.

In industry, conditions which require special belts vary from the space and weight limitations of machine tool manufacturers, to the "full surge" loads which hit a set of V-Belts when peak power is applied instantaneously.

For the answer to your drive problem, whatever it is, contact the V-Belt manufacturer who supplies 76% of the toughest V-Belt drive market in the world — The Dayton Rubber Co., Ind. O.E.M. Div., Dayton 1, Ohio.



Dayton's exclusive Cog design operates at maximum efficiency over the widest range of speeds. Still, it lends maximum crosswise rigidity to prevent squashing under heavy impulse loads. With surer gripping raw edges, Dayton Variable Speed Cog-Belts are double assurance of accurate control at all speeds.

*TM

Dayton Rubber

WORLD'S LARGEST MANUFACTURER OF V-BELTS

Industrial Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Dayton, Minneapolis, Moline, New York, San Francisco and St. Louis

OBERHAUSEN

SUPERCHARGERS

ELECTRIC • ENGINE • EXHAUST • TWO STROKE • PULSE-JET • SOLID PROPELLENT

FEATURES:

- ADAPTS TO ANY AND ALL CARS
- SIMPLIFIED INSTALLATION
- LOW SILHOUETTES FOR LOW HOODS
- USE YOUR STOCK CARBURETOR
- CARBURETOR NOT PRESSURIZED
- ASSEMBLED OR IN KITS
- COMPRESSOR BYPASS STANDARD
- OPERATE ONLY WHEN NEEDED
- DASH REGULATION OPTIONAL
- TRANSFERABLE, CAR TO CAR
- QUICK CHANGE MANIFOLD
- QUICK CHANGE COMP. HEAD

TYPICAL INSTALLATION

336 *COMBINATIONS TO CHOOSE FROM*

65% BOOST; 107 HP INCREASE
ON STOCK 283 cu. in. CHEVY, USING AN INEXPENSIVE MODEL

OBERHAUSEN ENGINEERING CORP.
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☐ $1.00 ENCL. RUSH 28 PAGE DELUXE FULL COLOR CATALOG

☐ $5.00 ENCL. RUSH 150 PAGE INSTALLATION MANUAL PLUS DELUXE CATALOG

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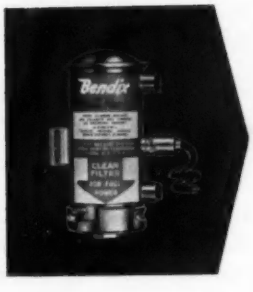
SOUTHWEST
"Monoball"
SELF-ALIGNING BEARINGS

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for Engineering Manual No. 551. Address Dept. SAE59

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA



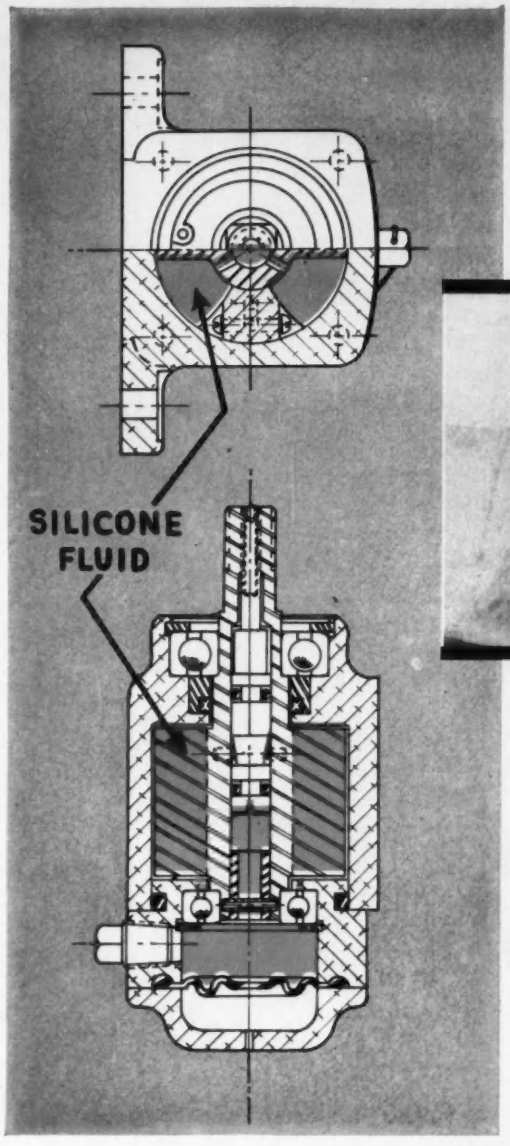
No. 1 IN PERFORMANCE
IN DURABILITY
IN ECONOMY

BENDIX ELECTRIC FUEL PUMP FOR EVERY INDUSTRIAL USE

In every type of industrial application, the Bendix* Electric Fuel Pump has proved itself with outstanding performance under extremely adverse conditions. In tests conducted under U. S. military supervision, it has proved itself at temperatures ranging from 114° to −76° Fahrenheit. It's easy to install and service, has a built-in pressure release, pumps more gallons per hour and positively prevents vapor lock. It will outperform any other fuel pump anywhere near its price. Write for descriptive folder and specifications. *REG. U.S. PAT. OFF.

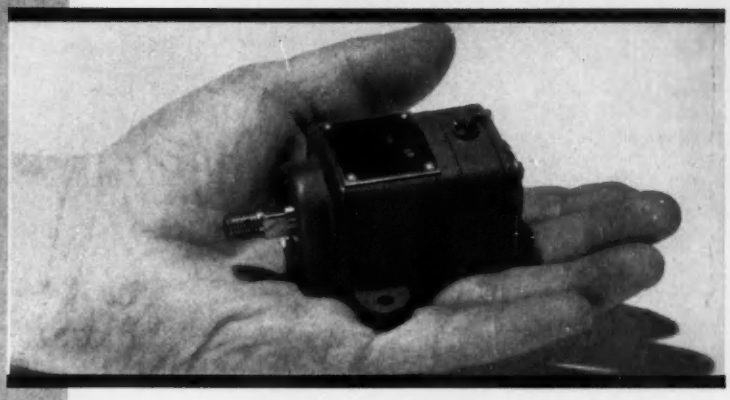
Bendix-Elmira, N.Y.
ECLIPSE MACHINE DIVISION

Bendix
AVIATION CORPORATION



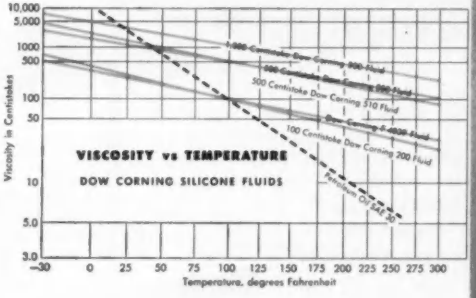
VIBRATION DAMPER EFFECTIVE OVER 225 DEGREE RANGE, NEEDS NO TEMPERATURE COMPENSATION

Sesco Manufacturing, Inc., produces an extensive line of aircraft vibration damping mechanisms utilizing Dow Corning Fluids. Shown is the Model 1025 Miniature Viscous Damper, which damps at rates of 0.5 to 25 inch-pounds per radian per second at 70 F. This unit, effective from —65 to 160 F, needs no temperature compensation over its entire range due to the silicone fluid's stability and indifference to temperature change. Vibration damper Model 1025 offers the advantages of small size, light weight, and minimum friction torque.



How to design for higher efficiency with SILICONE FLUIDS

Dow Corning silicone fluids offer you wider design latitude through many advantages not found in petroleum-base oils. Silicone fluids show little change in viscosity over broad temperature ranges. Resistance to oxidation and to breakdown due to shear are excellent. Damping force, torque transmission and rate of flow through an orifice are remarkably uniform. These properties make Dow Corning fluids more efficient media for damping, torque conversion and hydraulic applications. Also, their greater compressibility under very high pressures makes them ideal for liquid springs. For more information on properties and performance data, call our technical representatives in the branch office nearest you, or write Dept. 9113.



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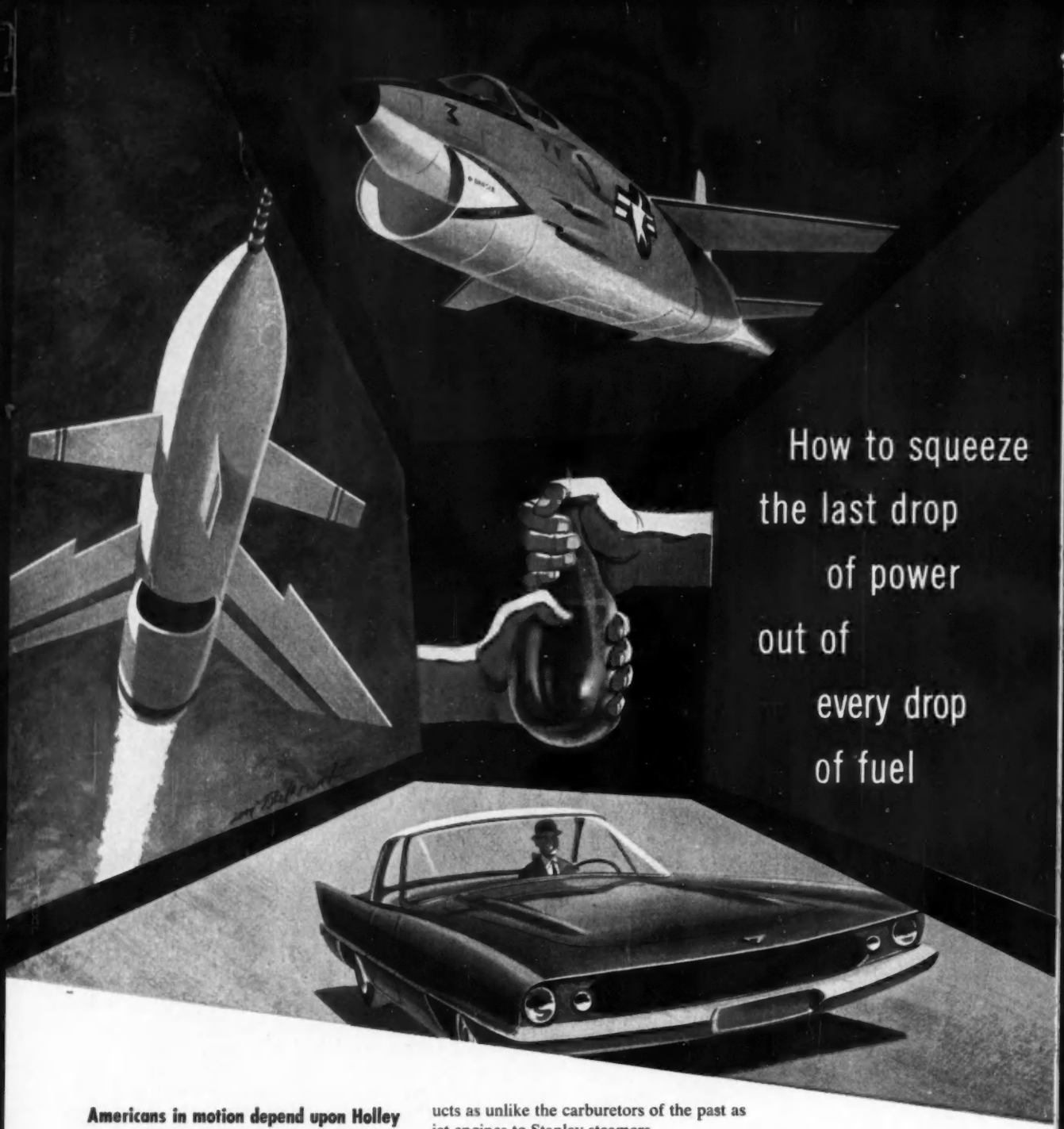

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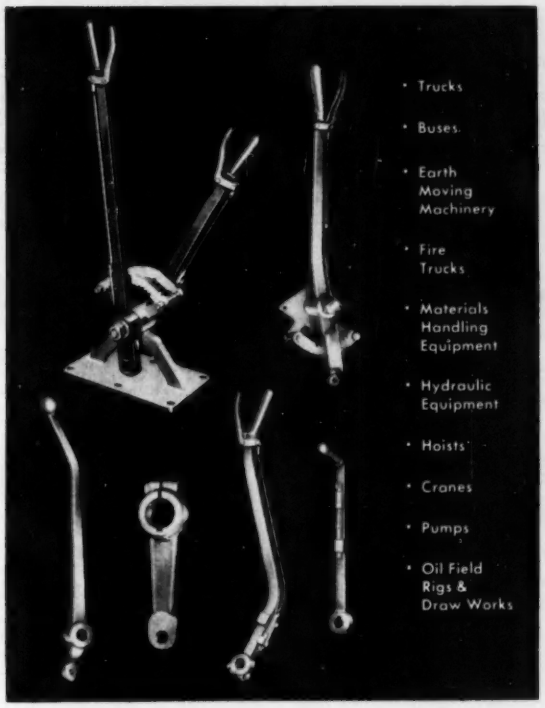

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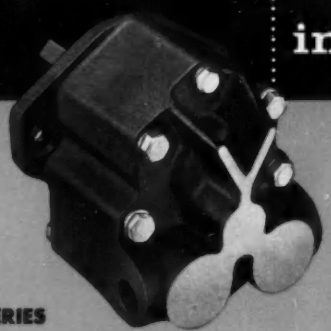

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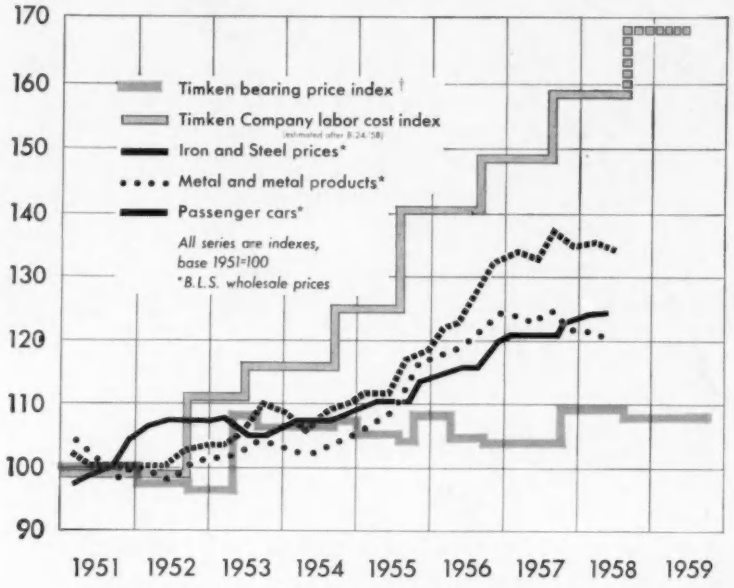

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